HAS THE OPTIMAL TARIFF THEORY EVER BEEN APPLIED IN THE REAL WORLD?

by

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B.S, KANSAS STATE UNIVERSITY, 2012

A REPORT

submitted in partial fulfillment of the requirements for the degree

MASTER OF ARTS

Department of Economics
College of Arts and Sciences

KANSAS STATE UNIVERSITY
Manhattan, Kansas

2014

Approved by:

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Abstract

Terms-of-trade argument (the optimal tariff theory) refers that a country with market power can gain national welfare when they impose a tariff for foreign exports and generate welfare at the expense of foreign trade partners. This argument has been long-term applied as an assumption in many theoretical trade models. Feenstra (2004) shows that the theoretical optimal tariff is equal to the inverse foreign export supply elasticity which implies if we can get the value of inverse export elasticity for each good then we can set up the optimal tariff to maximized our national welfare. Compared with the development in theory, the progress in the empirical study of terms-of-trade argument has been a bit stagnant until recent years. Christian Broda, Nuno Limão and David Weinstein (2008) show us an important empirical evidence that countries use market power when they set up tariff in their non-cooperative trade policy. And they estimate both import demand elasticity and export supply elasticity at the four-digit Harmonized System level by using 16 countries' trade data and production data. In this report, we firstly introduce the theoretical basis of optimal tariff. Then we will discuss the contributions of Broda et al (2008) and other economists' empirical findings of optimal tariff theory which applies Broda, Limão and Weinstein's estimates of elasticities.

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Acknowledgements

I would like to thank my major professor Dr. Peri da Silva, for his continuous support and extremely useful and detailed comments. I am grateful to Dr. Philip Gayle and Dr. Leilei Shen for being my committee members. I thank them for their suggestions and encouragement. I also want to thank Nick Colsch and Noah Miller for grammar revising. Last but not least, I would like to thank Kansas State University and the Department of Economics for providing such a great experience in the master program of study.

Chapter 1 - Introduction

It has long been known that countries could benefit from the application of a tariff if the country displays market power in international market. This idea was originally labeled as the "optimal tariff" theory by Charles Bickerdike's (1906) paper. This argument was elaborated further by the British Economist Nicholas Kaldor finds that if the duty is not too large, if the country has monopoly power on the world markets and if the other countries will not retaliate it later, the levying country then could have a terms-of-trade gain. So we would expect that if a country has economically large power in world market, it would be more likely that this country can have a terms-of-trade gain from tariff imposition. In Robert Feenstra's (2004) textbook, it shows the optimal tariff is equal to the inverse of export supply elasticity faced by the importing country.

Although the theoretical foundation on the optimal tariff theory is well established, the application of optimal tariff is rare. Some economists believe that this theory is hard to study using empirical methods because of the difficulty in estimating export supply elasticity of the rest of the world (Krugman, Obstfeld and Melitz 2010, p226). Broda, Limão and Weinstein's (2008) test the optimal tariff theory using a sample of 16 countries that were not members of the World Trade Organization (WTO) in the early 1990s. They "find strong evidence that countries have market power and employ it in setting higher tariffs in the non-cooperative trade policy" through estimating import demand elasticity and export supply elasticity (Broda et al 2008). Since then, their work has served as a source of inspiration to other scholars' work as they try to understand the workings of the WTO and the behavior induced by this institution on its members.

Given the importance of Broda, Limão and Weinstein's finding, this report first introduces the concept of optimal tariff and discusses its usefulness by relying on a historical example related to the protectionist agenda prevailing in the US and other nations during the 1930s. Second, we discuss the validity of the optimal tariff argument using a sample of non-WTO members where the paper by Broda, Limao and Weinstein (2008) plays a central role. Third, we describe the influence of the WTO in changing the tariff setting behavior of new members and how market power affects certain features of the WTO agreement.

The report is organized as follows. Chapter 2 describes the basic theory of optimal tariff which includes cost-benefit analysis for terms-of trade gain in the large country case as well as theoretical explanation for the relationship between optimal tariff and foreign export supply elasticity. Chapter 3 mainly discusses Broda, Limão and Weinstein's (2008) and other economists' empirical contributions of optimal tariffs theory and describes how these economists study the terms-of-trade argument using Broda, Limão and Weinstein's estimated elasticities. Chapter 4 extends the work by Broda et al. (2008) by considering how the multilateral negotiations under the WTO shape the economic behavior of new members and how market power matters in determining certain features of that agreement such as the level of tariff bounds.

Chapter 2 - The Terms-of-trade Argument

2.1 What is the Terms-of-Trade Argument?-General Analysis of Tariff

In the international trade market, a country usually exports the domestic products and services to other countries and imports foreign goods and services they needed. Terms-of-trade is defined as a ratio of export prices and import prices. It can also be interpreted as the relative amount of import goods that a country can purchase with a unit of export goods (Reinsdorf, 2010). A terms-of-trade improvement means that the country can buy relatively more foreign products and services with a unit of its exports than before. A terms-of-trade loss will occur if the prices of imported goods and services rise when prices of exported products keep constant (i.e. the imported products become relatively expensive).That is to say, when the relative price of imported products increase, the country can only get fewer imports for any given amount of export products.

For more than a century ago, many economists studied in international trade advocated free trade theory in the literature. As early as in 1817, David Ricardo used an example of New England and Portugal to illustrate the benefits of trade in his theory of comparative advantage. This theory kindled the belief of free trade since then. When it got to the twentieth century, the establishment of World Trade Organization (WTO) supports the 'free trade' idea in a more practical way. "Negotiating the reduction or elimination of obstacles to trade (import tariff, other barriers to trade)" is considered as one of main activities in the WTO mission statement (Lamy). Within WTO, trade barriers are being reducing significantly among members.

A different voice against free trade came out at the beginning of twentieth century. Some researchers argued that, instead of free trade, imposing tariff can benefit the levying country. Charles Bickerdike "introduced it purely technical reasons as a mean demonstrating that a country would gain from the imposition of a tariff" (Chipman, 1993). A welfare gain was illustrated in a Marshallian supply-demand diagram where the welfare of government revenue was over than consumer loss in his paper (Bickerdike, 1906). Later, in 1940, British Economist Nicholas Kaldor found that if the duty is not too large, if the country has monopoly power on the world markets and if the other countries will not retaliate it later, the levying country then could have a terms-of-trade gain. (Kaldor, 1940)

2.2 Costs-Benefits Analysis of a Tariff

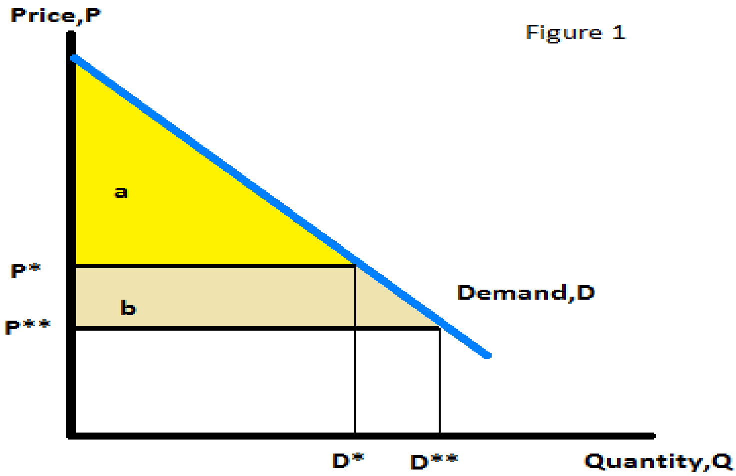
Theoretically, the gain from terms of trade can be identified by a cost-benefit analysis. To compare the loss and gain, we need to learn two economic concepts in advanced.

Consumer surplus (CS) "measures the amount a consumer gains from a purchase by computing the difference between the price he actually pay (P*) and the price he would have been willing to pay (WTP)" (Krugman at al 2012, P.198).

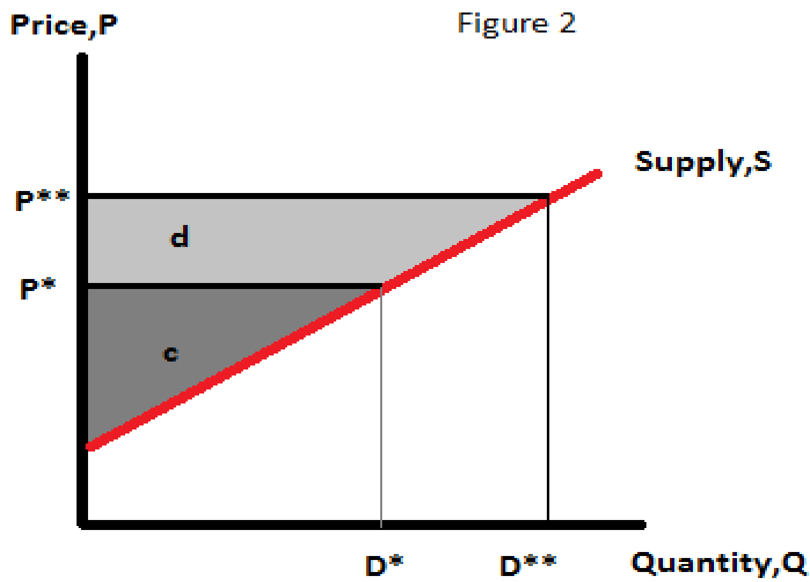
For instance, a consumer would like to pay $3 to buy one gallon of water. But the market price of water per gallon (P*) is $1. It implies that consumer buys a gallon of water with a price less than the amount of his willing to pay. So, the consumer gains a surplus, which is $3-$1=$2 from this purchase. Now suppose we buy more than one gallon of water, say we buy 2 gallons of water, the WTP of second gallon will be smaller than the WTP of first gallon (i.e. water is assumed to be a normal good to us and have a downward demand curve). Buying more gallons of water, the WTP for each gallon of water will keep decreasing. Finally, the WTP will be equal to P*at certain amount of good, say 10 gallons. This is to say, at 10th gallon of water, consumer is willing to pay $1 which is equal to market price and thus receive no consumer surplus for this unit of purchase. The consumer stops purchasing at the 10th gallon of water because the WTP of the 11th gallon of water is worth less than the market price (P*) to consumer. Consumer would not like to purchase the 11th gallon of water under this situation.

In Figure 1, at P*, consumer stops buying at the D*th good. The yellow triangle area "a" represents the consumer surplus when market price is P*. As the market price goes down to P**, consumers gain more from each good than before by a larger gap between WTP of each good and market price. Also, consumers can buy more goods at P** than at P*. So the consumer surplus will increase. At the new market price, P**, consumer will purchase D** amount of good

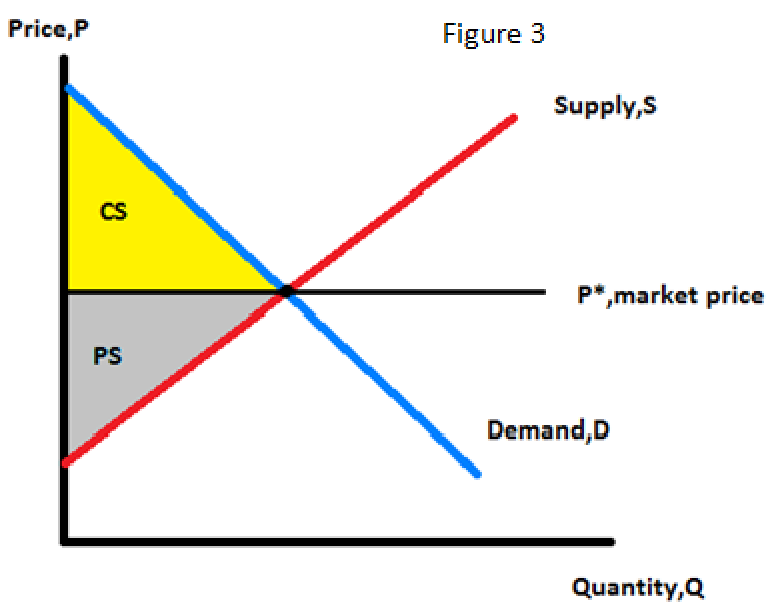
(D** is larger than D*). New consumer surplus becomes area “a” plus area “b”. Light yellow area “b” is the difference of consumer surplus for the price change.



Producer Surplus has a similar idea as consumer surplus. It is defined as the amount a producer gains from a product by computing the difference between the price he actually sell (P*) and the price he is willing to sell. In figure 2, the producer surplus at P* is shown as the dark gray triangle area “c”. Consumer stops buying at the D*th good. When the market price increases to P**, the producers would like to sell more products than before and they gains from each good sold will increase. The new producer surplus at P** turns to be the area “c” plus area “d”. Light gray area “d” is the difference of producer surplus when P* increase to P**.



When showing the supply and demand curve together in figure 3, we can notice that consumer surplus is equal to the upper triangle that under the demand curve and above the market price. Producer surplus is represented as the gray area that above supply curve and below the price.



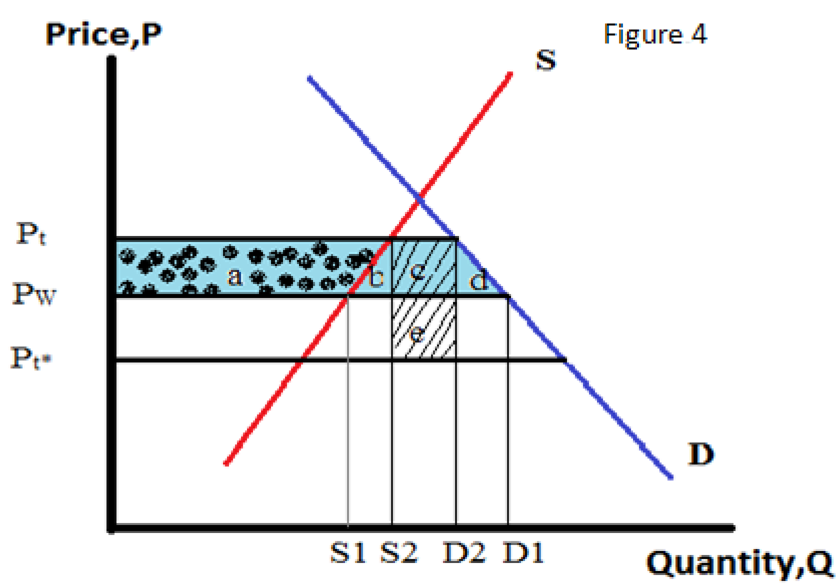
2.2.1 Large Country Case

In Figure 4, the diagram compares the cost and benefits we gain from imposing tariff with that of free trade in an economically large country.

Suppose there are two major parties in the trade system: home country and foreign countries. Home country is assumed to be an economically large country and the foreign countries are small countries which have no ability to affect the world price. Home country imports products from these small countries.

When these two parties participate in the free trade system, everyone is a price taker. Suppose the market price under free trade is $P_{w,}$ consumers in home country demands D_1 amount of goods but the domestic producers only supply S_1 amount of goods at P_w. There exists a shortage (D_1-S_1) at P_w. To satisfy the quantity demanded at P_w, home country need to import (D_1-S_1) amount of products.

But since home country is economically large, it can take advantage of its large market power to affect the import price.



After imposing a tariff t on this product, the cost of import increases and leads an increase in the domestic price. Domestic consumers will inevitably share a part of this tariff burden when price increases from P_w to P_t. Because the domestic price goes higher, producers in home country would like to supply more products while domestic consumers will decrease their quantity demand than before. At the higher price P_t, domestic producers produce S_2 amount of goods while consumers' demand fall to D_2.The shortage becomes smaller. Home country only needs to import (S_2-D_2) amount of products from foreign counties to reach the domestic market equilibrium. As for the foreign countries, the decrease of shortage in the home country can cause a much fierce trade competition among the foreign small countries. Foreign exporting countries need the 'large' country's orders. However, they have little market power. To maintain their market share in home country, these 'small' foreign counties would like to accept a price lower than the free trade price, P_t* in exchange for the home country's orders. The more market power home country has, the lower P_t* is. The price gap between the domestic price and foreign exported price is equal to the amount of tariff imposed (i.e. P_t-P_t*=t).

Domestic consumers face an increase from P_w to P_t. People could only buy fewer products at this higher price (because the demand curve is downward slopping). The consumer surplus shrinks and decreases by the area ("a"+"b"+"c"+"d") in Figure 4. This shows consumers get less benefit from levying than from free trade. In other words, consumers are hurt by imposing tariff.

On the other hand, as the price goes up, the domestic producers benefit from raising price. Domestic suppliers would like to produce more and the corresponding producer surplus increases which is indicated by area "a".

Other than these, home government also benefits from levying because home government generates revenue from the tariff imposition. The generated government revenue is equal to the product of quantity imported Q_t and tariff rate t, which denoted as the sum of area "c" and "e".

Thus, the net welfare of home country is: consumer loss minus domestic producer gain and minus government revenue (Krugman *et al*,p.201). Plugging in all the representative areas of these gains and loss, we get (a+b+c+d)-a-(c+e) = b+d-e as the net national welfare in Figure 4.

Here, area "e" represents the amount of government revenue generated at the expense of foreign countries' welfare. Area "e" is defined as 'terms of trade gain' because this gain can only be possibly attained when we trade with others countries (Krugman *et al*, p201). If the deadweight loss "b+d" is smaller than terms-of-trade gain "e", it implies that the benefit we gain when sacrifices welfare of the other parties outweighs the cost we pay for the tariff. Therefore, the net welfare of home country increases. In this game, home country becomes a winner at the expense of the welfare loss in other countries. So this policy is a “baggar-thy-neighbor” policy.

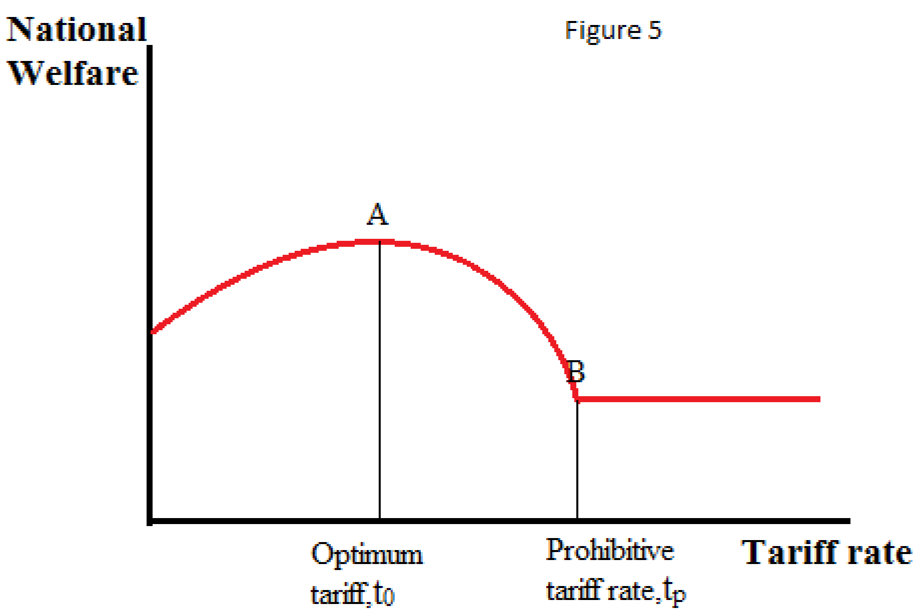
The amount of gain in terms-of-trade “depends on the ability of the tariff-imposing country to drive down foreign export prices”(Krugman *et al*, P.201). In other word, if home country has economically larger market power, the gap between P_w and P_t* can be bigger. Then, the national welfare of home country will increase even more.

So following this logic, as the tariff rate increases, the national welfare of home country will increase. However, “the costs eventually begin to grow more rapidly than the benefits and the curve relating national welfare to the tariff rate turns down”(Krugman *et al*, P.225). When tariff rate keeps growing, home country would keep decreasing the quantity imported at the same time. When this tariff reaches to a certain level, it could be too high for foreign countries to export products to home country. In addition, the domestic production will be sufficient to domestic demand. As a result, home country will turn into Autarky (i.e., closed economy and import is zero). During this process, there is an "optimum rate of the duty is that which maximizes the excess of the gain from terms-of-trade improvement over the losses" (Humphrey, 1987) so that the national welfare is maximized as well. After the national welfare maximizing, it will then declines along with the increase in tariff. At the prohibitive tariff rate t_p, national welfare is less than the national welfare of Free Trade (t=0) since free trade is better than Autarky.

2.2.2 Optimal Tariff Rate

The tariff rate that maximizes national welfare is called optimum tariff. In figure 5, at point A the corresponding tariff rate is optimum tariff. At point B, the welfare curve levels off because the tariff rate "completely prohibits trade leaves the country worse off than with free trade" (Krugman *et al*, P.225) and the rate beyond this prohibitive tariff rate have no impact on trade and welfare.

Figure 5



So now, the problem becomes how we can find out the optimum tariff and use concept of the terms-of-trade argument to maximize the national welfare when country has market power.

2.3 What Affects Optimum Tariff? -Formal Analysis of Tariff

The theoretical model of optimum tariff in Feenstra's textbook (2004) is shown as follows:

Assume that each individual h=1,….,H has preferences described by $c_0^h+U^h(c^h)$ where c_0^h is the numeraire good and c^h is an imported good. Each individual maximizes utility subject to the budget constraint: $c_0^h+p\,c^h\leq I^h$. Define the welfare function as the summation of the individuals' indirect utility functions. In this case, the assumption of quasilinearity assures that the indirect utility function of each individual h equals $I^h - pd^h+U^h(d^h)$ *where* $c^h=d^h(p)$.

The social welfare function is

$$W(p,I)=\sum_h[I^h+U^h(d^h(p))-pd^h(p)] \qquad (2.1)$$

Note that $U^h(d^h(p))-pd^h(p)$ stand for individual h' consumer surplus and its derivate with respect to prices is $-d^h(p)$.Total income can be collected from labor income, tariff revenue and profits: $I^h = L+tm+py-C(y)$.

Suppose that $p=p^*+t$. p represents domestic price after imposing tariff, p^* is denoted as the price for foreign export, and t is the tariff rate.

Total differentiate (2.1) with respect to t, yields

$$\frac{dW}{dt}=-d(p)\frac{dp}{dt}+m+\left(t\frac{dm}{dp}+y\right)\frac{dp}{dt}+\left(p-C'(y)\right)\frac{dy}{dt} \qquad (2.2)$$

Using the fact that the quantity demanded for imports, *m=d-y*.

The first term in the left hand side of equation (2.2) $-d(p)\frac{dp}{dt}=-m\frac{dp}{dt}-y\frac{dp}{dt}$. Rewrite the total differentiated equation, we have

$$\frac{dW}{dt}=-(m+y)\frac{dp}{dt}+m+\left(t\frac{dm}{dp}+y\right)\frac{dp}{dt}+\left(p-C'(y)\right)\frac{dy}{dt}=\frac{dW}{dt}$$
$$=m\left(1-\frac{dp}{dt}\right)+\left(t\frac{dm}{dp}+y\right)\frac{dp}{dt}+\left(p-C'(y)\right)\frac{dy}{dt} \qquad (2.3)$$

We can use the fact that $\frac{dp}{dt} = \frac{dp^*}{dt} + 1$, so $\frac{dW}{dt}$ can be simplified as follows

$$\frac{dW}{dt} = -m\frac{dp^*}{dt} + t\frac{dm}{dp}\frac{dp}{dt} + \left(p - C'(y)\right)\frac{dy}{dt} \qquad (2.4)$$

Under perfect competition, p=$C'(y)$, then $\frac{dW}{dt} = -m\frac{dp^*}{dt} + t\frac{dm}{dp}\frac{dp}{dt}$. Evaluate $\frac{dW}{dt}$ at t=0,gives us $\frac{dW}{dt}|_{t=0} = -m\frac{dp^*}{dt} > 0$ (for a large country, $\frac{dp^*}{dt} < 0$). Thus, a large country can be beneficial from imposing tariff. As we have seen from figure 5, at point A, the welfare get the maximum. $\frac{dW}{dt} = 0$ at point A.

We obtain $\frac{t^*}{p^*} = \frac{\frac{dp^*}{dt}\frac{m}{p^*}}{\frac{dm}{dp}\frac{dp}{dt}}$. When we use the concept that total imports equal total foreign export (m=x), the optimal ad-valorem tariff equals:

$$\frac{t^*}{p^*} = \frac{\frac{dp^*}{dt}\frac{x}{p^*}}{\frac{dx}{dp^*}\frac{dp}{dt^*}} = \frac{1}{\frac{dx}{dp^*}\frac{p^*}{x}} = \frac{1}{\varepsilon_x} \qquad (2.5)$$

where ε_x is the elasticity of foreign export supply. Therefore, the elasticity of foreign export supply has an inversed relationship with optimum tariff (i.e., $\frac{t^*}{p^*}$). The more inelastic the foreign export supply faced by a country, the higher the optimum tariff should be.

2.4 Difficulties of Application on Terms-Of-Trade Argument

Paul Krugman argues that the terms of trade argument against free trade has some obvious shortcomings. In his opinion, there are two main problems as follows. Firstly, in reality, most of countries in the world are economically small countries. These countries have very limited influence on the world prices of either their imports or their exports. Imposing tariffs in small countries will not let them earn benefits but hurt their national welfare as a whole instead. To these small countries, they should advocate free trade undoubtedly based on the opinion of Krugman. Therefore, the theory of optimum tariff is 'useless' to these small countries (Krugman, one-minute).

Second reason Krugman mentioned, is that after the large country imposing optimum tariff on certain foreign product, there is a chance that other countries will retaliate it back by using similar strategies on the exported products from this country. Moreover, it will attract countries into a vicious cycle of retaliation and can result in a trade war. Even though, each country can get terms-of-trade benefits from imposing tariff on the "enemy's" products. However, this benefit will be cancelled out by its loss from trade barriers imposed in "enemy" country that target to it. And, at the same time, trade war harms the global economic welfare (Krugman, one-minute).

We take the example of United States in 1930s, when the government imposed Smoot-Hawley (S-H) Tariff Act. The goal of this act was to protect the American working opportunities and agriculture. But the high S-H duties caused a "trade war" situation at that time. Followed by the imposition of Smoot-Hawley tariff, Canada, Great Britain, and other European countries imposed trade barriers to U.S. products. Based upon Jakob Madsen's estimation, "real world trade contracted about 14 percentages" from 1929 to 1932 due to "deflation-deduced discretionary tariff changes, nontariff barriers and income" (Madsen 2001). As for the effect on U.S. national market, "it alone accounts for about 7 percent of decrease in U.S. import and the higher effect tariff accounts for about 22 percent of the observed 40 percent decline in the volume of U.S. import in two years after Smoot-Hawley's imposition" by Douglas Irwin's assessment (Irwin, 1998). From the Smoot-Hawley case above, we can see that tariff imposition need to be cautious. We can get the terms-of-trade gain only when foreign countries do not retaliate. If trade war happens, no party will be better off.

Thomas Humphrey (1987) also points out some assumptions of optimum tariff theory make the terms-of-trade argument very unrealistic to apply in the real trade activities. According to his paper, there are three main theoretical assumptions is very unlikely happen in the daily life. First of all, the extent of elasticity of foreign export supply should be “not so large enough in the long run” to offset the tariff ineffectiveness (Humphrey 1987). Then, “optimum tariff rate can be precisely identified and skillfully administered” as well as the politicians “can resist pressures’ from lobby or their own political goals, ‘to raise tariff above the optimum level” (Humphrey 1987). The optimum duty also needs other assumptions to be theoretically provable.

Besides of problems in assumptions, the difficulty of calculating market power makes it “only theoretical usefulness” (Feenstra 2004). In equation (2.5), it shows that optimal ad-valorem tariff is equal to the inverse of foreign export supply elasticity. However, this is not a trivial question since we usually have many suppliers in reality. When tariff is imposed on one kind of good, it sometimes includes many different types, sizes which makes optimal tariff more difficult to measure. Therefore, to obtain each product’s optimum tariff, we need to measure export supply elasticity from foreign exporting counties. This calculation requires adequate trade data, and proper empirical econometric analysis. Unless we measure the elasticity correctly, we cannot make any conclusion on whether the economically large country implement market power to gain terms-of-trade benefits from trade or not.

Chapter 3 - Empirical Studies on Tariffs and Terms-of-Trade Argument

Christian Broda, Nuno Limão and David Weinstein (2008) show us an important empirical evidence that countries use market power when they set up tariff in their non-cooperative trade policy. And they estimate both import demand elasticity and export supply elasticity at the industry level by using 16 non-WTO countries’ trade data and production data. In this chapter, we introduce some literature which attempt to empirically test the terms-of-trade argument in tariff rates ’setting. We will mainly discuss the contributions of Broda *et al* (2008) and other important empirical findings which based upon Broda, Limão and Weinstein’s estimated elasticities.

3.1 The United States is a Small Country in World Trade

The premise of the terms-of-trade argument is the country has market power in the international trade market. The long term belief among international economists is that United States can have substantial influence on world prices. For instance, Krugman, Obstfeld, and Melitz (2010) claim that “for big countries like the United States, the problem is that the terms of trade argument amounts to an argument for using national monopoly power to extract gains at other countries’ expense. The United States could surely do this to some extent.” Carbough (2008, p.151) states that “a likely candidate for a nation imposing an optimum tariff would be the United States.” These statements are not plausible enough to persuade us that the United States is a large country. Without showing quantitative evidence, the United States is a large country can only be considered as a guess.

To investigate this problem, Christopher Magee and Stephen Magee (2008) give us a different conclusion on it by examining the effect of U.S. export tariffs on world prices. They argue that “for the vast majority of industries, the United States is a small country.” They use three different measurements to assess the United States market power in world trade in the paper. Firstly, they consider market share for each importing country as a measure of market power. Then, they assess value of Herfindalh-Hirschman Index (HHI) for world imports and world exports to know the level of market concentration. Moreover, Magee and Magee (2008) use the elasticity from Mansur and Whalley (1984) and Kee et al(2004) to estimate impacts of US tariffs on world prices. In the following sections I will further introduce the methods and results in Magee and Magee’s (2008) paper.

3.1.1 Data of Magee and Magee (2008)

Magee and Magee (2008) use two different datasets in their paper. To analyze country’s trade share, market concentration and U.S tariff effect on world price, they use 2003 annual world trade data from CIA World Fact Book in 2004 which includes import values and export values for each country and the overall world imports and exports. CIA reports import value in US dollars. As for examining industry level‘s market concentration and U.S tariff effect on world prices, they use 27 three- digit ISIC manufacturing industries data in 1992 for the reason of data completeness.

3.1.2 Market Share and Herfindahl-Hirschman Index (HHI)

Magee and Magee (2008) use aggregated data of country imports in 2003 to get market share of each importing countries in world trade market. They rank top 20 major importing countries by total value of imports in that year and evaluate their market power using Areeda and Hovernkamp’ s (1996, p.301) standard.

Notice that the standard for market power set in Areeda and Hovernkamp (1996) is actually targeted to single firm instead of to single country in world trade. Arreda and Hovernkamp

(1996) believe that if “defendant’s market share…has exceeded 70 or 75 percent for the five years ….”, we can assert that this firm has monopoly power in the market, “Most recent cases dismiss claims as a matter of law where the defendant’s market share is less than 50 percent” (Areeda and Hovernkamp 1996, p.301) which implies the U.S Department of Justice sets 50 percent as a cutting point to investigate whether a firm is able to control prices or not. Magee and Magee (2008) treat the United States as a firm and set world trade market as an industry level market using industrial organization economic methodology. Following the standard of Areeda and Hovernkamp (1996), Magee and Magee claim that since “the United States had 17% of world imports in 2003”which “falls far short of the 50% standard required”, U.S. is not sufficient to control prices in world trade market (Magee and Magee 2008).

However, recall Feensta’s (2004) model, we are not discussing issues about controlling price in the world trade market. Instead, we want to know about how a country affects the world price according to its export supply elasticity. Eventhough the U.S. has substantial import market share in some products, it does not necessary mean that the U.S. have significant market power in these products. For example, Netherland, Hongkong, Singapore import much more than the U.S. relative to its GDP. But it doesn’t imply that they play more important roles in world market as the U.S.

The US Department of Justice takes HHI as a reference index in its analysis of merge enforcement. According to the guideline of US Department of Justice, “the HHI is calculated by squaring the market share of each firm competing in the market and then summing the resulting numbers”(HHI,USDOJ). Magee and Magee (2008) find that “HHI of world imports equals to 561 and 415 for world exports”. Both of these values fall in the range of 0 to 1000 and indicate world trade "is not concentrated" (Magee and Magee 2008). Thus, the US trade share is too low to have a significant influence on world prices based on their results.

3.1.3 Magee and Magee's Model on Price Change

Magee and Magee (2008) start analyzing with a simple supply-demand model in the following:

$$Q_{d,row} + M_{us} = P^{\varepsilon_d} \qquad (3.1.1)$$

$$Q_{s,row} + X_{us} = P^{\varepsilon_s} \qquad (3.1.2)$$

- M_{us} denotes US imports
- X_{us} denotes US exports
- $Q_{d,row}$ denotes the quantity demanded in the rest of world
- $Q_{s,row}$ denotes the quantity supplied in the rest of world
- ε_s and ε_d are constant elasticities for supply and demand respectively.

Setting equations (3.1.1) and (3.1.2) equal to each other, they get the percentage change in world price as follows:

$$\%\Delta P_w = (1 + \frac{\Delta M_{us}}{Q_{s,row} + X_{us}})^{\left(\frac{1}{\varepsilon_s - \varepsilon_d}\right)} - 1 \qquad (3.1.3)$$

Keeping world price constant, the change of US imports is affected by ad valorem tariff and the import demand elasticity. $\Delta M_{us} = M_{us} \cdot t_{av} \cdot e_{md,us}$.

Rewriting equation (3.1.3), we have the percentage change in world price by average tariffs which is given by,

$$\%\Delta P_w^{tariffs} = 1 + \left(\frac{M_{us} \cdot t_{av} \cdot e_{md,us}}{Q_{s,row} + X_{us}}\right)^{\left(\frac{1}{\varepsilon_s - \varepsilon_d}\right)} - 1 \quad (3.1.4)$$

- t_{av} denotes average ad valorem tariff

- $e_{md,us}$ denotes the import-weighted elasticity across industries in the United States

Magee and Magee (2008) assume that the US and the rest of world are in a unified market so that the world quantity demanded is exactly equal to the world quantity supplied. They estimate the US prohibitive tariff impact on world prices from equation (3.1.3). When tariff reaches to prohibitive tariff, US imports will fall to zero so then change in the US import ΔM_{us}, is euqal to $(M_{us2003} - 0)$. As for supply and demand elasticities, they apply Greene's (1990) consistent supply elasticity estimate $\widehat{\varepsilon_s}$ and Mansur and Whalley's (1984) median demand elasticity estimate $\widehat{\varepsilon_d}$. Substituting all these estimates with 2003 US trade data in the equation, Magee and Magee (2008) find that "world prices would fall on average by about 4.1%" if the United States turns in to Autarky. When they examine prohibitive tariff impact on each industry, only in footwear, apparel, leather products, professional and scientific equipment industry world prices will decrease by over 5 percentages if US blocks the imports. To the other industry, estimated prohibitive tariff effects on world prices are mild.

Magee and Magee (2008) examine effect of US tariff on world prices by using equation (3.1.4). In this equation, they use average ad valorem tariff for US in 2002 from World Bank reports, t_{av} =3.9% and import-weighted average elasticity estimates across industries in United States is from Kee et al (2004). Their estimated effect of tariff on world price change is close to Deardorff and Stern's result (1986). According to Deardorff and Stern (1986), if US tariff is cut by 50%, US terms of trade will fall by 0.9%. Magee and Magee find that when US tariff drops by 50%, US teams of trade will decreases by 0.11% based on their estimation. But notice that the U.S. is a member of WTO. It does not play non-cooperative strategy to its WTO trade partners. Also, according to WTO rules, it has to applied cooperative tariffs to other member countries. This fact suggests that only evaluate the effects in tariffs cannot describe true market power of the U.S.

As we know, other than tariff barriers, countries can employ non-tariff trade barriers (e.g. anti-dumping) and other discriminatory clause to other countries. So Magee and Magee (2008) conclusion could be misleading because they do not examine the other barriers' effects.

3.1.4 Magee and Magee's Optimal Tariff Model

To figure out US optimal tariff, Magee and Magee (2008) assume that we have a competitive market and supply and demand function has a linear form.

$$Q_s = a + bp \qquad (3.1.5)$$

$$Q_d = c - dp \qquad (3.1.6)$$

where b>0, d>0

Assuming that US is an economically large country and the US government impose a tariff t on a certain product, world price will decrease while US domestic price will go up. The optimal tariff equals:

$$t_{opt} = \frac{M_{ft}X}{(b+d)(1-X^2)} \qquad (3.1.7)$$

where $X = \left(\frac{M_{ft}}{Q_{s,row}}\right)\left\{\frac{(-e_{md,us})}{e_s - e_d\left(1 - \frac{(M_{us}-X_{us})}{Q_{s,row}}\right)\left(\frac{M_{us}}{Q_{s,row}}e_{md}\right) + e_{xs}\frac{X_{us}}{Q_{s,row}}}\right\}$

- M_{ft} denotes US imports under free trade

- b,d denote slopes of supply and demand curve

Magee and Magee (2008) calculate optimal tariff by using equation (3.1.7). They compare the applied tariff with the estimated optimal values then conclude that actual tariff has a strong and significant correlation with optimal tariff. The median industry optimal tariff is 3.59 percent which can cause world price to fall about 0.13 percent. Overall, US industry optimal tariffs cannot have a substantial impact on world price. Magee and Magee do not control or test any political factors in their trade model which other economist found importance in terms of trade theory (Handley and Limão 2010, Bagwell and Staiger 2011,Beshkar and Bond 2012). However, in some industries such as apparel, footwear, and professional and scientific equipment, US domestic prices shoot more than 10 percent. Notice that these are industries where the WTO has problems getting countries to cooperate.

3.1.5 Conclusion and Comments of Magee and Magee (2008)

Magee and Magee (2008) use three different ways to show the United States is not a large country. It is known that the United State is the only super country in the world and has the largest world trade share. Therefore, other countries can only be small countries in economic sense because they have less trade share than the US. They recommend that terms of trade argument can be ignored in policy making for all countries because the "super country" is not even a large country under their examination.

However, we have some worries in Magee and Magee's model. First, they didn't address product differentiation in the paper. They use aggregated industry level data to analyzing the optimal tariff effects on world price. It could be a problematic since every industry has many kinds of products, and different kind of products has different tariff rates. A country may have market power in some products and may not have power in other products in certain industry. So this country's market influence within the industry can be offset when we only examine at the aggregated industry level data instead of at a more detailed product level data. Second, Magee and Magee (2008) may have problems in applying a cross-industry average ad valorem tariff and one consistent estimate of supply elasticity ε_s through all industries. As we know that different industries and different product always have different supply curves, there must be supply elasticities and ad valorem tariffs related to different industries and products. Using a universalized value in the estimation is inappropriate.

Though Magee and Magee (2008) give us new ideas on current countries' market power and terms of trade argument, we still have many problems on these issues. Considering the simplified model and some assumptions in Magee and Magee's (2008) study, we want to look at these problems by a more sophisticated model with more realistic assumptions. Also, not only studying economic giants such as the United States, but also we want to testify whether small countries have no market power in world trade or not.

3.2 Optimal Tariff and Market Power: The Evidence

Although optimal tariff has direct relationship with foreign export supply elasticity in theoretical international trade model (as shown in equation (2.5)), there is no literature that empirically show the effects of foreign export supply elasticity on tariff. To quantify the importance of terms-of-trade notion in trade policy, Broda, Limão and Weinstein utilize the methodology of Feenstra (1994) which we presented in chapter two as well as the method developed by their own in Broda and Weistein (2006) to estimate the export supply elasticity (Broda *et al* 2008). We first discuss the trade theory Broda et al (2008) test and. the estimation model for export supply elasticites. Second, we describe the dataset in Brada *et al* (2008). In the last part, we review the important results of Brada *et al* (2008) for a robustness check.

3.2.1 Theory and Data of Broda et al (2008)

To testify the positive relationship between levying and inverse elasticity, we first need to correctly measure export supply elasticity. In the paper, researchers also share the same idea. Christian Broda, Nuno Limão and David Weinstein (2008) mention that "a key reason why the impact of market power on tariffs has not been examined before is the difficulty of obtaining reliable measures of the elasticity of foreign export supply."

Prior to estimate elasticities, Broda, Limão and Weinstein set up a system of import and export equations in the following (Broda *et al* 2008):

$$\Delta^{k_{ig}} \ln s_{ig\nu t} = -(\sigma_{ig} - 1)\Delta^{k_{ig}} lnp_{ig\nu t} + \varepsilon_{ig\nu t}^{k_{ig}} \qquad (3.2.1)$$

$$\Delta^{k_{ig}} lnp_{ig\nu t} = \frac{\omega_{ig}}{1+\omega_{ig}} \Delta^{ig} lns_{ig\nu t} + \delta_{ig\nu t}^{k_{ig}} \qquad (3.2.2)$$

where g denotes good, ν denotes variety, i denotes country, and t denotes time. Variables are defined as:

- σ_{ig} denotes import demand elasticity of good g in country i and assumed to be constant over varieties and this time period.
- ω_{ig} denotes inverse export supply elasticity of good g in country i and also assumed to be constant over varieties and this time period.
- $s_{ig\nu t}$ denotes the share of import for each variety ν of good g in country i.
- $p_{ig\nu t}$ denotes the domestic price of variety ν of good g in country i.
- k_{ig} denotes the benchmark variety of the same good g imported by country i. Δ represents time difference. This difference operator is defined as $\Delta^{k_{ig}} \ln s_{ig\nu t} = \Delta \ln s_{ig\nu t} - \Delta \ln s_{igk_{ig}t}$

  $\Delta^{k_{ig}} lnp_{ig\nu t} = \Delta\, lnp_{ig\nu t} - \Delta lnp_{igk_{ig}t}$.

- $\varepsilon_{igvt}^{k_{ig}}$ denotes demand shocks that differ across varieties, $\varepsilon_{igvt}^{k_{ig}} = \varepsilon_{igvt} - \varepsilon_{igk_{ig}t}$.

- $\delta_{igvt}^{k_{ig}}$ denotes shocks to export supply that differ across varieties, $\delta_{igvt}^{k_{ig}} = \delta_{igvt} - \delta_{ig\,k_{ig}t}$. Demand shocks and supply shocks are assumed to be uncorrelated, $E_t\left(\varepsilon_{igvt}^{k_{ig}}\delta_{igvt}^{k_{ig}}\right) = 0$.

Solving (3.2.1) and (3.2.2), yields,

$$\left(\Delta^{k_{ig}} lnp_{igvt}\right)^2 = \theta_{i1}\left(\Delta^{k_{ig}} lns_{igvt}\right)^2 + \theta_{i2}\left(\Delta^{k_{ig}} lnp_{igvt}\Delta^{k_{ig}} lns_{igvt}\right) + u_{igvt} \quad (3.2.3)$$

where $\theta_{i1} = \frac{\omega_{ig}}{(1+\omega_{ig})(\sigma_{ig}-1)}$, $\theta_{i2} = \frac{\omega_{ig}(\sigma_{ig}-2)-1}{(1+\omega_{ig})(\sigma_{ig}-1)}$, and $u_{igvt} = \frac{\varepsilon_{igt}^{k_{ig}}\delta_{igvt}^{k_{ig}}}{\sigma_{ig}-1}$.

Instead of regressing θ_{i1} and θ_{i2} for each time period on (3.2.3), Broda, Limão and Weinstein (2008) do a between regression on equation (3.2.3) to obtain the consistent estimates of θ_{i1} and θ_{i2} as:

$$\bar{Y}_{igt} = \theta_{ig1}\bar{X}_{1,igv} + \theta_{ig2}\bar{X}_{2,igv} + \bar{u}_{igv} \quad (3.2.4)$$

where $Y_{igt} = \left(\Delta^{k_{ig}} lnp_{igvt}\right)^2$, $X_{1,igv} = \left(\Delta^{k_{ig}} lns_{igvt}\right)^2$ and

$X_{2,igv} = \left(\Delta^{k_{ig}} lnp_{igvt}\Delta^{k_{ig}} lns_{igvt}\right)$, the bars on variables denote time averages.

As for tariffs, the general model is written as follows: ν

$$\tau_{ig} = \beta f(\omega_{ig}) + \eta_{iG} + x_{ig}\gamma + u_{ig} \qquad (3.2.5)$$

where i, g follows the same notation from equation (3.2.3). G denotes industry which is belongs to one of the 21 sections of the Harmonized Tariff Schedule (an industry category standard for the United States import). Variables in equation (3.2.5) are defined as:

- τ_{ig} denotes ad valorem tariff of good g in country i.
- β is a parameter which assumed to be identical for all countries in baseline results, i.e. $\beta_i = \beta$ for all countries.
- η_{iG} denotes "industry-by-country effect" where $\eta_{iG} = \eta_G + \eta_i + v_{iG}$. $v_{iG}$is error term
- u_{ig} denotes the error term
- x_{ig} denotes an vector of determinants of tariffs such as product characteristics, industry-level characteristics which are correlated to market power and may affect tariffs.

In this paper, there are three different kinds of data needed which are tariff data, domestic production data and trade data respectively. To follow the "non-cooperative" assumption in theory, the country cannot be a member of the WTO during the period we study (Broda *et al*, 2008). It means if the country has dominant market power, its optimal tariff could be high as when it applies non-cooperative trade strategy. But since the WTO tries to promote corporation, the country need to decrease to a tariff level that favors other members so that states can receive equal trade advantages as the Most Favored Nations (MFN). The mechanism of the WTO violates the assumption of non-cooperation. Therefore, we cannot study WTO members using the data after they join the WTO.

In this paper, Broda, Limão and Weinstein (2008) only focus on the countries which tariff data "for at least one year before accession (GATT/WTO)" are available. In this sample, there are 15 countries are included. Sample countries have various sizes. The sample includes some “non-negligible countries” such as Taiwan, Ukraine, Russia, and China as well as some relatively small countries. The sample countries consist “25 percent of world population and close to 20 percent of world GDP” (Broda *et al* 2008). Thus, studying these countries can give us an important reference when we look at the impacts of terms of trade argument on international trade as a whole.

The trade data come from the United Nations Commodity Trade Statistics (COMTRADE) Database which consists of import quantity and unit value at six-digit Harmonized System (HS) level. For Taiwan, trade data come from TRAINS database because COMTRADE does not have data for it. Production data are collected from the United Nations Industrial Development Organization (UNIDO). UNIDO reports data for Bolivia, China, Ecuador, Latvia, Lithuania, Taiwan and Ukraine. Production data for the rest of countries are unavailable.

3.2.2 Elasticity Estimates of Broda et al (2008)

The original dataset is at six-digit HS level which provides the most detailed information for the products. Broda, Limão and Weinstein (2008) use data at six-digit HS level to calculate an average elasticity for a product at four-digit HS level because the elasticity at four-digit level “already sufficiently” provide information to their estimations. In their analysis, over 12,000 elasticities are estimated at the four-digit HS level. A summary statistics for inverse export supply elasticity is presented in Table 3.1.

In Table 3.1A, it shows the median and mean of inverse export supply elasticity across terciles for each country. The estimates of median inverse supply elasticity for low market power goods (i.e, goods with the estimated inverse export elasticity at the bottom thirty-three percentile in a country) in sample countries limits from 0.1 to 0.4. While for medium market power goods, the range is from 0.9 to 3.0. The estimates of elasticity for high market power goods become even larger. Median inverse supply elasticity in Taiwan and Paraguay are over 100 which implies one percent increase in prices leads less than 0.01 percent increase in the amount of export for their high market goods. Broda *et al* (2008) worry about the potential imprecise estimation in top tercile market power goods.

Table 3.1A- INVERSE EXPORT SUPPLY ELASTICITY STATISTICS

Statistic	Observations	Median			Mean		Standard Deviation	
Sample	All	Low	Medium	High	All	W/out top tercile	All	W/out top tercile
Algeria	739	0.4	2.8	91	118	23	333	47
Belarus	703	0.3	1.5	61	85	15	257	36
Bolivia	647	0.3	2	91	102	23	283	19
China	1,125	0.4	2.1	80	92	17	267	35
Czech Republic	1,075	0.3	1.4	26	63	7	233	18
Ecuador	753	0.3	1.5	56	76	13	243	30
Latvia	872	0.2	1.1	9	52	3	239	8
Lebanon	782	0.1	0.9	31	56	7	215	18
Lithuania	811	0.3	1.2	24	65	6	235	16
Oman	629	0.3	1.2	25	209	7	3,536	21
Paraguay	511	0.4	3	153	132	67	315	169
Russia	1,029	0.5	1.8	33	48	8	198	18
Saudi Arabia	1,036	0.4	1.7	50	71	11	232	25
Taiwan	891	0.1	1.4	131	90	20	241	43
Ukruaine	730	0.4	2.1	78	86	16	254	34
Median	782	0.3	1.6	54	85	13	243	30

Source: Broda et al 2008, table 3A. Notes: Number of observations for which elasticities and tariffs are available. The tariff availability did not bind except for Ukraine, where it was not available for about 130 HS4 goods for which elasticities were computed. The median over the "low" sample corresponds to the median over the bottom tercile of inverse elasticities. Medium and high correspond to the second and third terciles.

Broda, Limão and Weistein (2008) use bootstrapping to evaluate the precision of estimated elasticities. They "resample the data and compute new estimates for each of the elasticities 250 times"(Broda *et al*, 2008). A summary bootstrapped statistics for inverse export supply elasticities is reported in Table 3.1B.

TABLE 3.1B- BOOTSTRAPPED STATISTICS FOR INVERSE EXPORT SUPPLY ELASTICITIES

Statistics	Low		Medium or high	
Sample	Median	Confidence Interval	Median	Confidence Interval
Algeria	0.5	[0.10,0.8]	5	[2.0,81]
Belarus	0.3	[0.03,0.5]	3	[0.9,58]
Bolivia	0.4	[0.02,0.6]	4.2	[1.1,87]
China	0.6	[0.15,0.8]	5	[1.5,59]
Czech Republc	0.3	[0.06,0.5]	3	[0.9,30]
Ecuador	0.4	[0.02,0.6]	3.3	[0.9,63]
Latvia	0.3	[0.02,0.4]	2.3	[0.7,60]
Lebanon	0.2	[0.01,0.3]	2.1	[0.6,29]
Lithuania	0.3	[0.03,0.5]	2.3	[0.7,28]
Oman	0.4	[0.04,0.6]	2.2	[0.6,35]
Paraguay	0.5	[0.03,0.8]	6.7	[1.9,98]
Russia	0.6	[0.12,0.7]	3.8	[1.3,42]
Saudi Arabia	0.5	[0.10,0.7]	4.1	[1.4,44]
Taiwan	0.3	[0.01,0.3]	3	[0.8,98]
Ukruaine	0.6	[0.08,0.9]	4.5	[1.4,59]
Median	0.4	[0.04,0.6]	3.4	[1.1,49]

Source: Broda et al 2008, table 3B. Notes: The individual estimates for the 1-2α confidence interval are obtained via the bias-corrected percentile method (Bradley Efron 1981) using α =0.1.

Broda, Limão and Weinstein (2008) find that confidence intervals of estimates do not overlap across categories of goods in different levels of market power for each country.These distinguished confidence intervals for categories of goods in low market power and medium or high market power indicates the precision of estimates. They classify goods into three categories— commodities, reference priced goods and differentiated goods by adopting standard of James E.Rauch (1999) and estimates inverse export supply elasticity for each kind of goods. They find that differentiated products has highest estimated inverse elasticity, estimates of reference priced goods ranks in the middle and commodities which trade on organized exchanges have the lowest estimate. Their results confirm the conjecture that differentiated products have highest market power followed by reference priced good and then commodities.

3.2.3 Estimating the Impact of Market Power on Tariffs of Broda et al (2008)

Broda, Limão and Weinstein argued that "expressing tariffs purely in terms of an aggregate country's characteristic …is not very useful from an empirical perspective" when considering the complexity of cross-country variations (Broda *et al*，2008). So, in their paper (see equation (3.2.4)), tariff is expressed in a combination of many factors including market power, country characteristic as well as industry determinants. They present OLS and Tobit estimates of optimal tariffs and market power across goods within countries in Table 3.2.

Country effects are included in the first three columns. In column 4 to column 9, industry variables are also added into the specifications. It is clear from Table 3.2 below that the effect of market power on tariffs does not vary much across specification. In the idea of Broda, Limão and Weinstein, the estimated average optimal tariff has economic importance when comparing the actual tariff rates in real world. For instance, the estimated average optimal tariff in China is around 37 percent in Table 3.2 which is "roughly the same magnitude of China's average tariff over all goods" (Broda *et al*, 2008).

When these researchers employ instrumental variables in estimation, they find that the coefficient for dummies for medium and high market power products having 9 percentage points higher tariffs than low market power products. This shows strong evidence that sample countries do apply market power in tariff setting.

Besides proving the significant market power effect on non-WTO member countries tariffs, Broda *et al* (2008) also study the role of market power by the United States, a large member of the WTO, when it trades non-cooperatively with other countries. They find that market power is a key determinant when it sets statutory tariffs. Within WTO's role, there is "no such effects on US tariffs set" (Broda *et al*, 2008) according to their observations. They also provide evidence that market power also matters when US set nontariff barriers but since this is outside the area of our investigation, we will not introduce it here.

TABLE 3.2- TARIFFS AND MARKET POWER ACROSS GOODS(WITHIN COUNTRIES): OLS AND TOBIT ESTIMATES

Dependent variable	Average tariff at four-digit HS (%)								
Fixed effects	Country			Country and industry					
Estimation method	OLS	OLS	OLS	OLS	OLS	OLS	Tobit	OLS	OLS
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Inverse exp.elast.	0.0003 (0.0001)			0.0004 (0.0004)					
Mid and high inv exp elast		1.24 (0.25)			1.46 (0.24)			1.86 (0.31)	
Log(1/export elasticity)			0.12 (0.04)			0.17 (0.04)	0.17 (0.05)		
(Inv. Exp.elast) × (1-med hi)								1.45 (0.31)	
(Inv. Exp.elast) × med hi								0.0003 (0.0001)	
Mid inv.exp.elast.									1.56 (0.28)
High inv.exp.elast									1.37 (0.28)
Algeria	23.8 (0.64)	23.0 (0.65)	23.6 (0.64)	24.6 (0.95)	23.6 (0.96)	24.3 (0.95)	24.3 (0.93)	23.1 (0.97)	23.6 (0.96)
Belarus	12.3 (0.29)	11.5 (0.33)	12.2 (0.29)	12.6 (0.76)	11.6 (0.78)	12.5 (0.73)	12.4 (0.94)	11.3 (0.79)	11.7 (0.78)
Bolivia	9.8 (0.03)	9.0 (0.17)	9.7 (0.06)	10.1 (0.73)	9.2 (0.75)	10.0 (0.73)	10.0 (0.95)	8.8 (0.77)	9.2 (0.75)
China	37.8 (0.77)	37.0 (0.79)	37.7 (0.77)	38.2 (0.98)	37.2 (1.01)	38.0 (0.99)	37.9 (0.89)	36.6 (1.03)	37.2 (1.01)
Czech Republc	9.5 (0.53)	8.7 (0.53)	9.4 (0.53)	9.7 (0.85)	8.7 (0.86)	9.6 (0.85)	8.8 (0.89)	8.3 (0.87)	8.7 (0.86)
Ecuador	9.8 (0.19)	9.0 (0.26)	9.7 (0.20)	10.3 (0.73)	9.4 (0.74)	10.2 (0.73)	10.1 (0.93)	9.0 (0.76)	9.4 (0.74)
Latvia	7.3 (0.35)	6.4 (0.40)	7.2 (0.35)	7.3 (0.76)	6.3 (0.78)	7.2 (0.76)	6.9 (0.91)	6.0 (0.79)	6.3 (0.78)
Lebanon	17.1 (0.53)	16.2 (0.56)	17.0 (0.53)	17.1 (0.84)	16.1 (0.86)	17.0 (0.84)	17.0 (0.92)	15.9 (0.86)	16.1 (0.86)
Lithuania	3.6 (0.26)	2.8 (0.31)	3.6 (0.26)	3.6 (0.74)	2.6 (0.76)	3.5 (0.74)	-6.0 (0.98)	2.3 (0.77)	2.6 (0.76)
Oman	5.6 (0.34)	4.9 (0.37)	5.6 (0.34)	5.7 (0.77)	4.8 (0.79)	5.6 (0.77)	4.9 (0.94)	4.4 (0.79)	4.8 (0.79)
Paraguay	16.0 (0.49)	15.3 (0.52)	15.9 (0.50)	16.3 (0.84)	15.4 (0.85)	16.1 (0.84)	15.9 (0.99)	14.9 (0.86)	15.4 (0.85)
Russia	10.6 (0.34)	9.8 (0.38)	10.5 (0.34)	10.8 (0.77)	9.9 (0.79)	10.7 (0.77)	10.0 (0.89)	9.4 (0.82)	9.9 (0.79)
Saudi Arabia	12.1 (0.08)	11.3 (0.18)	12.0 (0.09)	12.4 (0.71)	11.4 (0.74)	12.2 (0.72)	12.1 (0.89)	10.9 (0.76)	11.4 (0.74)
Taiwan	9.7 (0.28)	8.9 (0.33)	9.6 (0.28)	10.3 (0.74)	9.3 (0.76)	10.1 (0.75)	9.7 (0.91)	9.0 (0.77)	9.3 (0.76)
Ukruaine	7.4 (0.28)	6.6 (0.33)	7.2 (0.29)	8.1 (0.74)	7.1 (0.76)	7.9 (0.74)	6.8 (0.93)	6.6 (0.78)	7.1 (0.76)
Observations	12,333	12,333	12,333	12,333	12,333	12,333	12,333	12,333	12,333
Numbers of parameters	16	16	16	36	35	36	35	38	36
Adj. R^2	0.61	0.61	0.61	0.66	0.66	0.66			0.66

Source: Broda et al 2008, table7. Notes: Standard errors in parentheses (all heteroskedasticity robust except Tobit). Industry defined by section according to Harmonized Standard tariff schedule.

3.2.4 Conclusions and comments on Broda et al (2008)

In Broda *et al*(2008), it is the first time we test optimal tariff theory by using actual theory-based measures of market power The effects of market power on tariffs are substantial which could be roughly the average of tariffs for non-WTO members (i.e. China). For the United States (which is a WTO member), the market power also play an important role in statutory tariff setting to Non-WTO countries.

Irwin (2010) points out that some small countries such as Belarus, Latvia, Lebanon, Oman, and Paraguay which shown significance effects on world price by estimating export supply elasticities in Broda *et al* (2008) are "very unlikely" to have influence in real world. Therefore, we should take into account the possibility of overestimation in Broda, Limão and Weinstein (2008)'s methodology. In addition, they rank goods in different levels of market power in a country manner where I dislike that much. I am more curious about the range of estimates for each country if we rank all countries' elasticities together and divide them into high, medium and low using the way of tercile.

Chapter 4 - Empirical Findings of Other Economists

4.1What Do Trade Negotiators Negotiate About? Evidence from the World Trade Organization

During accession process, the government applying for membership in the World Trade Organization needs to negotiate a trade agreement package with WTO member countries. The handbook on accession to WTO states that, "WTO Members request applicants … not to introduce new restrictive measures while the accession negotiations are in progress" (Handbook).

This requirement implies that the home country must not impose new trade barriers to WTO members, during the negotiation period, if they wish to join the WTO. Bagwell and Staiger (2011) assume that a home country uses terms-of-trade argument in setting its tariff prior to the accession and the application of term-of-trade theory increases international trade inefficiency. They argue that the purpose of negotiation is to provide foreign countries a chance to express their opinions in the home country's trade policy so that foreign countries can reduce their cost when they trade with the home country. Following this, the level of international trade efficiency could be increased after negotiations settle down by the internalization terms of trade externalities through trade negotiations sponsored by the WTO. In their paper, Bagwell and Staiger (2011) try to show us how the accession process to the WTO may promote cooperation in tariff setting. In particular, they empirically investigate the role of market power in the change of tariffs as countries become members of the WTO. The role of market power is identified by testing the relationship between tariff cuts, import volumes and prices, and trade elasticities.

4.1.1 Theoretical Model of Bagwell and Staiger (2011)

To simply the problem, Bagwell and Staiger (2011) assume that domestic demand and supply are expressed as:

$$\begin{cases} \mathrm{D(P)} = \alpha - \delta(\mathrm{P}), \\ S(P) = \lambda + \kappa(P), \end{cases} \qquad (4.1.1)$$

where, $\delta'(P) > 0, \kappa'(P) > 0,$ and with α and λ are corresponding shifters for domestic demand and supply.

Domestic import is defined as the difference between demand and supply, which is given by,

$$\mathrm{M(P)} \equiv \mathrm{D(P)} - S(P) = [\alpha - \lambda] - [\delta(\mathrm{P}) + \delta(\mathrm{P})] \qquad (4.1.2)$$

They assume that home government has an ad valorem tariff τ at the nonprohibitive level. Domestic market price is related to the world market price which can be expressed by:

$$\mathrm{P} = (1+\tau)P^W \qquad (4.1.3)$$

When the world market reaches a market clear condition, world price is denoted as $\tilde{P}^W$. So domestic price is rewritten as $\mathrm{P}\left(\tau, \tilde{P}^W\right)$.

Home government's objective welfare comes from three parts which are production surplus, consumer surplus and tariff revenue. Assume that this objective is presented as a weighted sum for the above three parts as:

$$\mathrm{W}\left(\mathrm{P}\left(\tau, \tilde{P}^W\right), \tilde{P}^W\right) = \gamma \mathrm{PS}\left(\mathrm{P}\left(\tau, \tilde{P}^W\right)\right) + \mathrm{CS}\left(\mathrm{P}\left(\tau, \tilde{P}^W\right)\right) + \left[\mathrm{P}\left(\tau, \tilde{P}^W\right) - \tilde{P}^W\right] \cdot \mathrm{M}\left(\mathrm{P}\left(\tau, \tilde{P}^W\right)\right) \quad (4.1.4)$$

where, γ denotes political economy multiplier. If $\gamma > 1$, it implies that government concerns political objectives in some industries while $\gamma = 1$ suggests that government's priority goal is to maximize national welfare without considering a specific party's loss and gain (i.e., no political economy in domestic market). By Envelope's theorem, the first order derivative of W with respects to $\tilde{P}^W$, which they denote by $W_{\tilde{P}^W}$, is given by,

$$W_{\tilde{P}^W} = -\mathrm{M}\left(\mathrm{P}\left(\tau, \tilde{P}^W\right)\right) \qquad (4.1.5)$$

Bagwell and Staiger (2011) assume that without considering the trade agreement, home government would set up their tariff level to maximize national welfare taking as given the tariff imposed by other countries. The reaction function for home country tariff can be derived from (4.1.4) as

$$W_p \frac{dP}{d\tau} + W_{\tilde{P}^W} \frac{d\tilde{P}^W}{d\tau} = 0 \qquad (4.1.6)$$

From equation (4.1.6), we obtain a unique best-response tariff τ^{BR}.

Using equation (4.1.4) and (4.1.5), equation (4.1.6) can be rewritten as:

$$\frac{-W_{\tilde{P}^W}\left(P^{BR}, \tilde{P}^{wBR}\right)}{\tilde{P}^{wBR}} = \eta^{BR} \qquad (4.1.7)$$

where variables are defined as

- σ^{BR} is the best-response import demand elasticity at the best-response tariff level τ^{BR}, $\sigma \equiv -\partial \ln M / \partial \ln P$.
- ω^{*BR} is the best-response foreign export supply elasticity under the world market clearing condition given τ^{BR}, $\omega^* \equiv \partial \ln E^* / \partial ln P^W$ (which E^* represents the destined foreign export for home country under market-clearing condition). For the case of small country, $\omega^{*BR} \rightarrow \infty$.
- M^{BR} is the amount of import given τ^{BR}.
- P^{BR} is the best-response domestic price given τ^{BR}
- η^{BR} is the pre-negotiation cost-shifter, $\eta^{BR} \equiv \left(\frac{\sigma^{BR}}{\omega^{*BR}}\right) \left(\frac{M^{BR}}{P^{BR}}\right)$.

When home government takes trade agreement into account for their tariff setting, Bagwell and Staiger (2011) assume that a "politically optimal" tariff is obtained when home government set tariff without considering terms-of-trade effects of its choice. Also, if all governments choose their tariffs in this way, then the series of political optimal taxes "would be efficient in light of the governments 'actual objectives. The political optimal tariff τ^{PO} is defined by,

$$W_p\left(P^{PO}, \tilde{P}^{wPO}\right) = 0 \qquad (4.1.8)$$

Furthermore, Bagwell and Staiger (2011) suppose that the home country "negotiates to join a trade agreement that requires all members to implement their politically optimal tariffs" when the world price is fixed. They then develop a function to show the relationship between τ^{BR} and τ^{PO}, holding the world price fixed, which is given by,

$$G\left(\tau^{BR}, \tau^{PO}, \tilde{P}^{wBR}\right) = \eta^{BR} \qquad (4.1.9)$$

Notice that terms-of-trade refers to the relative ratio of export price and import price. To assess the terms-of-trade gain (or loss) for home government, when it joins into a trade agreement and commits to tariff level τ^{PO}, Bagwell and Staiger define terms-of-trade term $r \equiv \tilde{P}^{wPO} / \tilde{P}^{wBR}$.

If r is greater than 1, then the politically optimal world price is higher than pre-negotiated world price so the home country's terms of trade will deteriorate. When r is less than 1, then the political optimal world price is less than the original world price. Thus, the home country would have a terms-of-trade improvement in negotiation.

When setting up the equilibrium between the pre-negotiated destined domestic imports and associated destined foreign exports, $M = E^*$ and assuming domestic supply and demand function in linear form (i.e., $\delta(\mathrm{P}) = \delta, \kappa(P) = \kappa$), equation (4.1.9) will be simplifies as:

$$[\tau^{BR} - \tau^{PO}] = \beta_0 + (\beta_1 - 1)\tau^{BR} + \beta_2 m^{BR} \quad (4.1.10)$$

where $\beta_0 = {[(\gamma-1)\kappa(r-1)]}/{\{r[\delta+\kappa-(\gamma-1)\kappa]\}}$, $\beta_1 = {1}/{r}$, and

$\beta_2 = {-\theta}/{\{r[\delta+\kappa-(\gamma-1)\kappa]\}}$, $m^{BR} \equiv {M^{BR}}/{\tilde{p}^{wBR}}$.

It tells us the negotiated tariff cuts only have a relationship with pre-negotiated tariff rates and the pre-negotiated import quantity.

Rearranging equation (4.1.10) yields,

$$\tau^{PO} = \beta_0 + \beta_1 \tau^{BR} + \beta_2 m^{BR} \qquad (4.1.11)$$

As we know that τ^{BR} and m^{BR} are the pre-negotiated variables and τ^{PO} is the post-negotiated outcome. Recall the pre-negotiation cost-shifting term $\eta^{BR} \equiv \left(\frac{\sigma^{BR}}{\omega^{*BR}}\right) \left(\frac{M^{BR}}{P^{BR}}\right) = \left(\frac{\sigma^{BR}}{\omega^{*BR}}\right) \cdot m^{BR}$.

If we know the value of import elasticity and export elasticity for each good, the ratio of $\left(\frac{\sigma^{BR}}{\omega^{*BR}}\right)$ can be treated as a constant ϕ.

Thus, equation (4.1.11) can also be expressed as:

$$\tau^{PO} = \phi_0 + \phi_1 \tau^{BR} + \phi_2 \eta^{BR} \qquad (4.1.12)$$

In the empirical testing, Bagwell and Staiger (2011) mainly use model (4.1.11) and (4.1.12) to confirm their prediction for the role of terms-of-trade theory.

Bagwell and Staiger (2011) use the models above to prove the application of terms-of-trade theory in the WTO negotiation. The models imply that the coefficients of β_2 and ϕ_2 are negative, and the coefficients of β_1 and ϕ_1 are positive. The empirical exercise requires a sample of countries that were not members of the WTO until 1994 so that we can observe the change in their policies as the accession process is concluded. The ancestor of WTO is General Agreement on Tariffs and Trade (GATT). Prior to the establishment of WTO, GATT had 128 contracting parties according to the member list of GATT ("GATT members"). After the establishment of WTO in 1994, all GATT contracting parties became WTO member countries while they were still following the agreements of GATT. During the period from January 1, 1995 to November of 2005, there were 21 new members that joined the WTO (Bagwell and Staiger, 2011).

Since the primary roles of GATT are tariff cutting and improving multilateral trade system, Bagwell and Staiger (2011) assume that contracting party countries had efficiently set up a political optimal tariff through the rounds and rounds of negotiations in the past sixty years. Thus, when the home country joins a WTO as a new member after 1995 and negotiates with all other WTO member countries, the home country is required to have a "once-for-all tariff cuts from best-response to politically optimal level" according to rules of WTO (Bagwell and Staiger, 2011). Then, the negotiated ad valorem bound tariff should be considered as the politically optimal tariff.

Bagwell and Staiger (2011) treat the pre-WTO applied tariffs for each country as the pre-negotiated best-response tariffs while the actual pre-accession import data is considered as the best-response import for each country under their assumptions.

The empirical benchmark models are written as:

$$\tau_{gc}^{WTO} = \beta_0 + \beta_1 \tau_{gc}^{BR} + \beta_2 m_{gc}^{BR} + \epsilon_{gc} \qquad (4.1.13\ a)$$

$$\tau_{gc}^{WTO} = \phi_0 + \phi_1 \tau_{gc}^{BR} + \phi_2 \eta_{gc}^{BR} + \upsilon_{gc} \qquad (4.1.13.b)$$

- τ_{gc}^{WTO} denotes ad valorem bound tariff for good g in country c in a GATT/WOT negotiation.

- τ_{gc}^{BR} denotes the best-response tariff for good g in country c which is observed as a pre-WTO applied tariff for country c on good g.
- η_{gc}^{BR} denotes the observed pre-WTO domestic cost shifter.
- ϵ_{gc} and υ_{gc} are error terms.

Recall that Bagwell and Staiger (2012) predict that the estimates of β_1 and ϕ_1 are positive and that the estimates of β_2 and ϕ_2 are negative. Because, domestic imports increase with increasing tariff cuts ($\tau_{gc}^{WTO} - \tau_{gc}^{BR}$), τ_{gc}^{WTO} would move in the opposite direction with m_{gc}^{BR} and η_{gc}^{BR} when we keep the best-response tariff fixed. Thus, if τ_{gc}^{WTO} increases, the tariff cut becomes smaller. As a consequence, import demand should decline. However, when we keep the import demand constant, in order to offset the effect of larger bound tariff (i.e., tariff cut becomes smaller) we should increase the pre-negotiated best-response tariff. τ_{gc}^{WTO} will move in the same direction with τ_{gc}^{BR}.

Bagwell and Staiger wish to identify the negotiated tariff and the pre-negotiated tariff so that they can study only those countries that have WTO and pre-WTO data. Bagwell and Staiger (2011) only consider the sample countries from the group of WTO new members. There were 21 countries that joined the WTO between the period of January 1, 1995 and November 2005. Because of data availability, five countries have no data available for this research. So, the sample consists of the rest 16 new member countries. Each country's bound tariffs and pre-accession tariffs are collected from TRAINS dataset at six-digit HS level. Import value data are obtained from the PC-TAS database (a subset of the COMTRADE database). To convert the import value data into import quantity data, Bagwell and Staiger (2011) also acquire unit value data from the COMTRADE database.

Recall that the empirical model (4.1.13.b) requires that estimates of import demand elasticity, σ^{BR}, and export supply elasticity, ω^{BR}, are computed in the cost shifting term η_{gc}^{BR} (as shown by the following: $\eta^{BR} \equiv \left(\frac{\sigma^{BR}}{\omega^{*BR}}\right) \left(\frac{M^{BR}}{P^{BR}}\right) = \left(\frac{\sigma^{BR}}{\omega^{*BR}}\right) \cdot m^{BR}$). And as we learnt in the previous chapter, Broda, Limão, and Weinstein (2008) estimate the import demand elasticity and the export supply elasticity at HS 4-digit level in a sample of 16 non-WTO countries. Five of these non-WTO countries became WTO members in the interval between 1995 and 2005. Bagwell and Staiger (2011) use the estimates of elasiticities obtained from Broda, Limão, and Weinstein (2008) in model (4.1.13.b).

Both model (4.1.13.a) and (4.1.13.b) can test the relationship between bound tariff, pre-accession tariff, and pre-accession import according to the terms-of-trade theory. Comparing the sample sizes in models 4.1.13.a and 4.1.13.b (16 vs. 5 countries), Bagwell and Staiger decide to focus on Model (4.1.13.a) and use (4.1.13.b) as a robustness check.

4.1.2 Estimation results for Bagwell and Staiger (2011)

Bagwell and Staiger (2011) estimate the model (4.1.13.a) "on the full sample of countries and products" classify goods by one-digit HS sector, which is given by,

$$\tau_{gc}^{WTO} = \alpha_G + \alpha_c + \beta_1 \tau_{gc}^{BR} + \beta_2 V_{gc}^{BR} + \epsilon_{gc} \quad (4.1.14.a)$$

$$\tau_{gc}^{WTO} = \alpha_G + \alpha_c + \beta_1 \tau_{gc}^{BR} + \beta_2 m_{gc}^{BR} + \epsilon_{gc} \quad (4.1.14.b)$$

- α_G denotes the industry fixed effect at two-digit HS level.
- α_c denotes the country fixed effect.

- V_{gc}^{BR} denotes import value acquired from PC-TAS database.

- m_{gc}^{BR} denotes the ratio of best-response import quantity to world prices. (i.e.,

  $M_{gc}^{BR} = {V_{gc}^{BR}}/{\tilde{p}^{wBR}}$, $m_{gc}^{BR} = {M_{gc}^{BR}}/{\tilde{p}^{wBR}}$)

Table 4.1-Baseline Results						
Equation:	τ_gc^WTO=α_G+α_c+β_1 τ_gc^BR+β_2 [V_gc^BR]+ϵ_gc					
	OLS				Tobit	
Sample	Obs	β_1	β_2	R^2	β_1	β_2
All	47,721	0.3702*** (0.0174)	-0.0044*** (0.0008)	0.804	0.3901*** (0.0051)	-0.0065*** (0.0010)
HS0	2,037	0.3750*** (0.0284)	-0.0733** (0.0338)	0.763	0.3925*** (0.0291)	-0.0657 (0.0443)
HS1	1,811	0.2226*** (0.0311)	-0.0476*** (0.0104)	0.783	0.2376*** (0.0218)	-0.0487*** (0.0095)
HS2	4,417	0.6502*** (0.0707)	-0.0001 (0.0015)	0.651	0.6781*** (0.0210)	-0.0053 (0.0051)
HS3	4,030	0.2679*** (0.0162)	-0.0044*** (0.0008)	0.868	0.2805*** (0.0098)	-0.0047*** (0.0015)
HS4	3,264	0.3285*** (0.0142)	-0.0059*** (0.0017)	0.919	0.3711*** (0.0147)	-0.0061 (0.0048)
HS5	4,271	0.3136*** (0.0104)	-0.0055*** (0.0015)	0.955	0.3163*** (0.0089)	-0.0055*** (0.0020)
HS6	4,176	0.1342*** (0.0144)	-0.0134*** (0.0044)	0.974	0.1342*** (0.0089)	-0.0134*** (0.0041)
HS7	4,293	0.3705*** (0.0185)	-0.0111*** (0.0025)	0.906	0.4144*** (0.0080)	-0.0057*** (0.0008)
HS8	10,956	0.4013*** (0.0159)	-0.0044*** (0.0006)	0.872	0.4144*** (0.0080)	-0.0057*** (0.0008)
HS9	3,466	0.3715*** (0.0176)	-0.0112* (0.0063)	0.886	0.4123*** (0.0179)	-0.0113 (0.0082)
Albania	2,172	0.2544*** (0.0208)	-0.0085 (0.0512)	0.870	0.3194*** (0.0256)	-0.0183 (0.0690)
Armenia	1,213	0.2693*** (0.0661)	0.0063 (0.0666)	0.878	0.3066*** (0.0686)	0.0058 (0.0789)
Cambodia	1,632	0.4979*** (0.0276)	0.0453** (0.0186)	0.951	0.4985*** (0.0136)	0.0450 (0.0304)
China	4,645	0.2584*** (0.0214)	-0.0044*** (0.0009)	0.862	0.2661*** (0.0079)	-0.0073*** (0.0008)
Ecuador	3,601	0.5703*** (0.0224)	-0.0607** (0.0244)	0.972	0.5703*** (0.0182)	-0.0607*** (0.0146)
Estonia	3,645	0.2124** (0.1060)	-0.0900*** (0.0289)	0.870	0.2456* (0.1409)	-0.1123*** (0.0195)
Georgia	1,388	-0.2285** (0.0974)	0.0457 (0.0280)	0.901	-0.4986*** (0.1598)	0.0441 (0.0436)
Jordan	3,333	0.6317*** (0.0310)	-0.0546** (0.0273)	0.931	0.6504*** (0.0096)	-0.0719*** (0.0214)
Kyrgyzstan	1,575	- -	-0.0790 (0.0666)	0.904	- -	-0.0909* (0.0506)
Latvia	3,253	0.1246*** (0.0385)	-0.0616*** (0.0184)	0.856	0.1286*** (0.0241)	-0.1263*** (0.0487)
Lithuania	3,515	0.4990*** (0.0445)	-0.0051 (0.0115)	0.850	0.5179*** (0.0223)	-0.0060 (0.0110)
Macedonia	2,643	0.4616*** (0.0174)	-0.0188 (0.0602)	0.859	0.6044***	-0.0183 (0.0544)
Moldova	1,872	0.4161*** (0.0329)	0.0009 (0.0031)	0.926	0.4755*** (0.0252)	0.0243 (0.1509)
Nepal	1,517	0.3516*** (0.0391)	-0.3998** (0.1810)	0.941	0.3527*** (0.0183)	-0.4073*** (0.1150)
Oman	2,824	-0.4555 (0.5301)	-0.0248** (0.0124)	0.765	-0.4662** (0.2351)	-0.0258 (0.0174)
Panama	3,691	0.1277*** (0.0179)	-0.0031*** (0.0010)	0.925	0.1300*** (0.0132)	-0.0032** (0.0012)

Notes: Standard errors are in parenthese (OLS are heteroskedasticity-robust). Source:Bagwell and Staiger (2011) Table 3.

Table 4.1 reports the estimates of β_1 and β_2 under (4.1.14.a) using OLS and Tobit .We can see that when we estimate the bound tariff, pre-accession tariff and import value in a sector manner, the estimates of β_1 and β_2 show economic significance. There is a very clear trend across sectors that the estimates of β_1 are positively significant while the estimates of β_2 in both models are negatively significant. But when the data are analyzed by country, the results are somewhat weak. Table 4.1 also shows the by-country estimates of β_1 and β_2 using OLS and Tobit. About half of the OLS estimates of β_2 show insignificance. This condition worsens when we estimate β_2 by Tobit. As for estimates of β_1, the results are significant in most cases but the significance level is decreased when we compare with β_1's by-sector results.

To improve the performance of by-country estimates of β_2 in Table 4.1, Bagwell and Staiger (2011) "permit country-specific variation of the estimated β_2's by sector. But the results are not improved. It is also clear that a country can import products from both WTO members and non-WTO members. This could raise the possibility of free-riding from tariff negotiations if the country extends the most-favored nation status to a country that is not a WTO member. Bagwell and Staiger think imports come from non-WTO members may affect the estimate results of β_2 if we just use the total import in the estimation without noticing the origins of products. So then they classify imports into two groups: WTO members and outsiders (i.e., non-WTO members). The benchmark empirical models are extended as:

$$\tau_{gc}^{WTO} = \alpha_G + \alpha_c + \beta_1 \tau_{gc}^{BR} + \beta_2 V_{gc}^{BR} + \beta_3 O_{gc}^{BR} + \epsilon_{gc} \quad (4.1.15.a)$$

$$\tau_{gc}^{WTO} = \alpha_G + \alpha_c + \beta_1 \tau_{gc}^{BR} + \beta_2 m_{gc}^{BR} + \beta_3 o_{gc}^{BR} + \epsilon_{gc} \quad (4.1.15.b)$$

- O_{gc}^{BR} denotes the import value of good g in country c which is supplied by outsiders.

  The sum of O_{gc}^{BR} and V_{gc}^{BR} is the total import value of good g in country c.

- o_{gc}^{BR} denotes the import quantity of good g in country c which is supplied by outsiders.

  $o_{gc}^{BR} = {O_{gc}^{BR}}/{\tilde{p}^{wBR}}.$

Bagwell and Staiger (2011) estimate β_1 ,β_2, and β_3 using OLS and Tobit. The results show that in some sectors and some countries, an increase in imports from outsiders has a substantially positive relationship with bound tariff while "the estimates of β_2 are not much affected" in the prediction of extended models.

Bagwell and Staiger(2011) propose the "actual" ad-valorem tariff barriers should include the applied tariffs as well as the estimated tariff equivalents of Non-tariff barriers (NTBs) to capture the trade restrictiveness. They calculate average applied tariff at 4-digit HS level and define them as the unbound tariff shown in Table 4.2. The tariff-equivalent estimates of the NTBs are obtained from Kee, Nicita and Olarreaga (2009) and constructed into the pre-WTO barriers, which they define as the "Unbound tariff+NTB" in Table 4.2.

Table 4.2 reports the comparison of unbounded valorem tariffs, ad valorem tariff-equivalents of NTBs and bound tariffs.

Table4.2- Comparison of Unbound Tariffs, NTBs, and Bound Tariffs				
	Unbound Tariff*	Unbound tariff + NTB	Bound tariff	Obs
All	9.8	16.67	10.67	25,302
HS0	12.48	28.5	18.45	1,339
HS1	14.57	25.21	17.73	1,081
HS2	8.64	14.42	10.3	2,765
HS3	8.4	15.72	6.15	2,312
HS4	9.08	15.33	8.63	1,956
HS5	11.46	14.99	10.31	2,604
HS6	17.4	24.19	15.82	2,472
HS7	7.91	13.4	9.13	2,480
HS8	6.45	13.8	9	6,281
HS9	10.66	15.66	10.68	2,012
Albania	16.7	17.35	7.71	2,187
China	18.72	25.07	9.76	4,645
Estonia	0.07	0.67	8.53	3,613
Jordan	22.03	45.73	16.05	3,332
Latvia	4.78	11.89	12.03	3,253
Lithuania	3.62	9.23	9.49	3,514
Moldova	4.63	6.83	6.95	1,871
Oman	4.69	9.87	13.23	2,824

*Notes:"Unbound tariff"represents the average pre-accession MFN-applied tariff over the sample at the periods . "NTB"represents the average ad valorem equivalent NTB measures as described in Kee, Nicita, and Olarreaga (2009). "Bound tariff"represents the final negotiated post-accession tariff binding.

We can see that the estimated pre-WTO tariff equivalent protection is well-above the bound tariff" on average across countries and sectors in Table 4.2. It implies the countries experience a significant tariff cuts after they finish negotiations over WTO accession. Bagwell and Staiger develop model (4.1.14.a) by estimating the tariff equivalent measures of NTBs as:

$$\tau_{gc}^{WTO} = \alpha_G + \alpha_c + \beta_1\left(\tau_{gc}^{BR} + NTB_{gc}\right) + \beta_2 V_{gc}^{BR} + \epsilon_{gc} \quad (4.1.16.a)$$

$$\tau_{gc}^{WTO} = \alpha_G + \alpha_c + \beta_1\left(\tau_{gc}^{BR} + NTB_{gc}\right) + \beta_2 m_{gc}^{BR} + \epsilon_{gc} \quad (4.1.16.b)$$

Where NTB_{gc} denotes ad valorem tariff equivalents of non-tariff barrier of good g in country c.

Their empirical results for (4.1.16) strengthen their earlier finding of pre-accession applied tariffs and pre-accession imports. They also test the possibility of the free-rider problem in world market, but their results shows insignificance. This is out of scope of our report, so we will not describe it here.

4.1.3 Comments on Bagwell and Staiger (2011)

Bagwell and Staiger(2011) argue that bound tariff can be estimated by the pre-negotiated applied tariffs, import volumes and prices with terms-of-trade theory. However as we can see, the relationship they identified is based on the assumptions of linearity in demand and supply functions, as well other unrealistic assumptions. And they predict negotiated tariff cuts using import value instead of using import quantity. And they only use five countries elasticity estimates in the robustness check. Five countries account less than one third of the total sample size (16 countries) which seems not enough for a check.

4.2 Tariff Binding and Overhang: Theory and Evidence

Broda *et al*(2008) show that if a country implements a non-cooperative tariff policy then its tariffs exploit that country's market power in international market. Another three international trade economists Mostafa Beshkar, Eric Bond, and Youngwoo Rho characterize the relationship between market power and tariff binding and overhang, which give us another angle to the relationship between market power and important features of the international trade system.

There are several differences between Beshkar, Bond and Rho(2012) and Broda *et al*(2008). First, Beshkar, Bond and Rho focus on studying how market power affects the setting of bound tariff and tariff overhang, while Broda, Limão and Weinstein discuss the impact of market power on applied tariff. A bound tariff is different from an applied tariff. A bound tariff is a duty negotiated in the WTO that constrains the member country from increasing the rate of tariff beyond the agreed level. Once the tariff is bound, the rate of duty "may not be raised without compensating the affected parties" (Tariff Bindings, Philippines Tariff Commission). Whereas, applied tariff is a "rate…used in current charging" which can be lower or greater than the binding level (Trade topics, WTO). Second, Beshkar, Bond, and Rho (2012) utilize a dataset consist of 66 WTO members countries, whereas Broda, Limão and Weinstein (2008) use a dataset of 16 non-WTO countries. Prior to Beshkar *et al* (2012)'s empirical test, Economists (e.g. Broda, Limão and Weinstein) assume that when countries join in an organization for trade cooperation, they are no longer "exercising their market power in trade policy" following the terms-of-trade arguments (Beshkar *et al*, 2012). The approach of Beshkar, Bond, and Rho (2012) however can analyze the relationship between market power and optimal tariff when countries are members of WTO. In the dataset of Beshkar, Bond, and Rho (2012), all important trade participants are included in the study such as the US, European Union, and Japan, which were not included in previous literature. Their study of 66 countries gives us a more comprehensive understanding about the application of market power in optimal tariff commitments.

4.2.1 Important assumptions and Predictions of Beshkar and Bond (2012)

They assume that government can only dispose ad valorem tariffs. An optimal tariff is assumed to be a function of political shocks, market power as well as domestic distortion regarding tariffs as:

$$t^N = t^N(\theta, \omega, \eta) \qquad (4.2.1)$$

- θ is domestic political shock for home country such that the first order derivative with respects to $\theta, t_\theta^N > 0$.
- ω is market power such that $t_\omega^N > 0$.

- η is domestic resources distortion regarding tariff. $\eta = \varepsilon \frac{m}{y}$ where ε denotes import demand elasticity and $\frac{m}{y}$ denotes import penetration ratio. $t_{\eta}^{N} < 0$, thus a large dead weight loss will cause optimal tariff decline.

As for information structure, they assume that home government is "uncertain about their future preferences regarding tariffs" (Beshkar *et al*, 2012). θ is assumed to be unobservable to other countries and there is no state-dependent relationships between countries. An Optimal Trade agreement is also incentive compatible. The maximization of the joint expected value of the negotiating parties' political functions subject to the incentive compatibility constraint suggests that the optimal contract takes the form of a tariff bound. This means that the importing country can apply its non-cooperative tariff if this tariff is below the bound while the tariff equals the bound otherwise. The optimal contract can be described as follows:

$$\mathrm{t}(\theta) = \begin{cases} t^{B} & if\ \theta \geq \theta^{B}(\theta^{B}, \omega, \eta), \\ t^{N}(\theta, \omega, \eta) & if \theta < \theta^{B}(\theta^{B}, \omega, \eta), \end{cases} \qquad (4.2.2)$$

A country has to choose the applied tariff to be equal to the bound, when the country has large market power and its optimal tariff is higher than the binding level. Since a rise in a bound tariff is hard to exercise and the compensation to other parties may be high, in order to make maximized welfare in the attainable condition, this large country should therefore choose t^{B} as its applied tariff rate. For other countries, which have low levels of market power and their optimal tariffs are lower than the tariff bindings, they should choose the optimal tariff to be their applied tariff in order to maximize their social welfare. Rearranging equation (3.13), the magnitude of tariff binding overhang is expressed by a function of g(θ), which is given by,

$$g(\theta) = \begin{cases} t^B - t^N(\theta) & if \theta < \theta^B, \\ 0 & if\ \theta > \theta^B, \end{cases} \qquad (4.2.3)$$

Beshkar, Bond and Rho (2012) present a corner solution for the relationship between market power and political shock and domestic distortion as follows:

$$\omega \geq \frac{E[\theta] - \underline{\theta}}{\eta - E[\theta]} \qquad (4.2.4)$$

- $\underline{\theta}$ denotes lower bound value for political shock that when $\theta \in [\underline{\theta}, \overline{\theta}]$, the trade agreement is incentive compatible for the home country.

According to Beshkar *et al* (2012), when $\omega > \frac{E[\theta] - \underline{\theta}}{\eta - E[\theta]}$, tariff overhang is always zero and optimal binding level is $t^B = \frac{E[\theta]}{\eta - E[\theta]}$ which is increasing in the expectation of political shocks $E[\theta]$ and decreasing in distortion. But when $\omega \leq \frac{E[\theta] - \underline{\theta}}{\eta - E[\theta]}$, there are tariff overhangs for some countries where tariff binding is decreasing in ω and increasing in the conditional expectation $E[\theta | \theta \geq \theta^B]$, the effect of η on tariff binding cannot be determined. When ω is "sufficiently small (large)", the average applied tariff has a positive (negative) relationship with market power (Beshkar *et al*, 2012).

4.2.2 Data and Empirical Model of Beshkar et al (2012)

The data of tariff bindings and applied tariffs are obtained from the WTO database. The current bindings have been unchanged since 1995. Writers mainly use cross-sectional applied tariffs data for 2007 (for some countries, they use data either from 2006 or from 2008 because of the data availability). Sample countries include "52 original members and 14 new members" (Beshkar *et al*, 2012). The applied tariff data is collected at the six-digit HS level.

Beshkar, Bond and Rho (2012) primarily use the Tobit model to predict the impact of market power on tariff binding and overhang, which are shown as the following respectively:

$$\begin{cases} t_{ij}^{B} = \alpha_1 \omega_{ij} + \beta_1 \eta_{ij} + \mathrm{X}_j \gamma_1 + \varepsilon_{ij}, \\ t_{ij}^{B} = t_{ij}^{B_*} & if\ t_{ij}^{B_*} > 0, \\ t_{ij}^{B} = 0 & if\ t_{ij}^{B_*} < 0, \end{cases} \qquad (4.2.5)$$

- t_{ij}^{B} denotes the observed tariff binding for sector i and country j. $t_{ij}^{B_*}$ represents the associated latent variable.
- ω_{ij} denotes international market power for sector i and country j.
- η_{ij} denotes domestic distortion for sector i and country j which equals to the product of import elasticity and import penetration ratio.
- X_j denotes a vector of characteristic variables at country-level
- . ε_{ij} is the error term.
- α_1, β_1 and γ_1 are parameters for the right hand side independent variables in the model. Beshkar, Bond and Rho's theory implies $\alpha_1 < 0$.The sign of β_1 is unknown.

As described above, the authors also consider the effects of market power on the tariff binding overhang. Their model suggests that the greater the market power of the importing country the lower should be the tariff overhang. To investigate this issue, they consider the following econometric framework:

$$\begin{cases} g_{ij}^{*} = \alpha_2 \omega_{ij} + \beta_2 \eta_{ij} + X_j \gamma_2 + \varepsilon_{ij}, & \\ g_{ij} = g_{ij}^{*} & \text{if } g_{ij}^{*} > 0, \\ g_{ij} = 0 & if\ g_{ij}^{*} < 0, \end{cases} \qquad (4.2.6)$$

- g_{ij} is the observed overhang for sector i and country j. g_{ij}^{*} denotes the associated latent variable.
- α_2 , β_2 and γ_2 are parameters for the right hand side independent variables in the equation. The sign of β_2 is unknown.

To measure the likelihood of zero tariff binding overhang with a change in the international market power, they propose a Probit model which is given by,

$$\Pr\left(t_{ij}^{A} > t_{ij}^{B} | \omega_{ij}, \eta_{ij}, X_{ij}\right) = \Phi\left(\alpha_3 \omega_{ij} + \beta_3 \eta_{ij} + X_j \gamma_3\right) \qquad (4.2.7)$$

- t_{ij}^{A} represents the applied tariff of sector i and country j while t_{ij}^{B} represents the regarding bound tariff.
- Beshkar, Bond and Rho's theory implies that $\alpha_3 < 0$

Notice that in the assumption of Beshkar, Bond and Rho (2012)'s model, international market power has a relationship with both inverse export elasticity and import share. They present their model of export supply elasticity as:

$$\varepsilon_i^{*} = {(\varepsilon^{X} + \sum_{k \neq i} \varepsilon_k W_k)}/{W_i} \qquad (4.2.8)$$

- ε_i^* is the true export supply elasticity for country i.
- ε^X is the world export supply elasticity.
- ε_k is import demand elasticity for country k.
- W_k is country k's share of the world import. Similarly, W_i is country i's share of the world import.

The estimated import demand elasticities are obtained from Broda *et al* (2008) and are at three-digit HS level. To address the endogeneity problem of market share, Beshkar *et al* (2012) "use GDP and per-capita endowment of several productive resources of the economy" as instrumental variables. The data of GDP and productive resources for each sample country are available from World Bank. As for political shock, Beshkar, Bond and Rho (2012) adopt the Economist Intelligence Unit (an index which used to assesses political instability) to control this factor. Notice that Economist Intelligence Unit is provided by the Economist Group (an influential economic mass media group). The credibility and reputation of this index should be questioned because it is not an 'academic' or 'official' index provided by World Bank or other international organizations and research institutions. In this paper, Beshkar *et al* (2012) merely introduce some factors that are used in the index construction. They admit that there is no good measure to quantify the political impacts across countries.

4.2.3 Empirical Results of Beshkar et al (2012)

Beshkar *et al* (2012) test market power effects on tariff binding and overhang in all sectors. They also test market power effects by utilizing output data of agriculture and manufacturing for the purpose of robustness. Table A.1 (see Appendix) reports the estimation results for tariff binding against with import share, market power growth (as in an log form), GDP per capita (as in a log form) and political instability. They find that market power growth is inversely related to tariff binding commitments in all sectors as well as in agriculture and manufacturing. But its significance only exists when analyzed for all sectors of all 66 member countries. Recall that Beshkar *et al* (2012) also use import share as a measure of market power. In Table A.1, import share shows a significant negative relationship with bound tariff in all sectors, agriculture and manufacturing, respectively. If we increase one standard deviation of import share, the tariff binding will decline by 3.5 to 4.46 percentage points. Import elasticity ε has no significant effect in all sectors and in agriculture though it shows a positive relationship to bound tariff. While in manufacturing, import elasticity presents an inverse relationship with tariff binding with significance. Political Instability also has a substantial impact on tariff binding commitments. If a country is much more political instable, the country tends to have higher bound tariffs (Based on the observation for all sectors and manufacturing).

Table A.2 (see Appendix) reports results for tariff overhang against market power and other variables. It shows similar results to those present in Table A.1. Market power controls (i.e., import share and export supply elasticity) have negative and significant impact on tariff overhang. In particular, the import share's effect becomes even larger in this model. A standard deviation increase in import share will increase tariff overhang by 8 to 17 percentage points. Political shocks also have significant and positive coefficients in all sectors and manufacturing but the significance level is reduced. Table A.3 (see Appendix) gives us a Probit regression result for the likelihood of zero-overhang against market power and other variables that controlled in Table A.1 and Table A.2. The empirical result shows that if a country have higher market power, it will be more likely that overhang is zero. Beshkar *et al* (2012) also find political factor significantly affects the likelihood. The country with greater political instability is less likely to have zero-overhang because government needs more flexibility in trade policy when they face greater uncertainty in governing.

Beshkar *et al* (2012) provide a theory and empirical supports on how terms-of-trade argument affects trade policy. These three Economists answer “why governments value flexibility in setting their policies” by empirically showing us the relationship between market power and tariff overhang (Beshkar *et al*, 2012). They also talk about some shortcomings for their theoretical models. For instance, they ignore “some important elements in trade agreement” such as “escape clause” and discrimination issues (e.g. anti-dumping) when constructing models because these elements have not been well explained in the literature (Beshkar *et al*, 2012).

Chapter 5 - Remarks

The optimal tariff theory has been well established during the twentieth century but its empirical evidence is rare. Some Economists argue that this theory is useless for the real world because most of countries are small countries which have very limited impact on world prices of products and terms of trade argument is a kind of “beggar-thy-neighbor” policy which may cause severe retaliation from other countries. Also, how to correctly estimate the export supply elasticity is another obstacle for the empirical research.

Broda, Limão and Weinstein (2008) first attempt to empirically testify the relationship between tariff and inverse of export supply elasticity. They utilize 16 non-WTO countries’ data and show us even the small countries apply terms of trade argument if they have market power in the product. Other Economists also make empirical contributions in the optimal tariff theory based upon the elasticities estimates of Broda, Limão and Weinstein (2008). Bagwell and Staiger (2011) find robust empirical evidence for the terms of trade argument application in the negotiated tariff cuts. They find that if a country have large import volumes before it join the

WTO, the negotiated tariff cuts will be large during the its accession process of WTO. Beshkar, Bond, and Rho (2012) predict the relationship between market power and the binding commitments and overhang between binding levels and applied tariffs. They also find empirical support for their predictions which show us the market power do play a central role in the setting of bound tariff as well as overhang. Therefore, as times goes on and the development of methodology, we would expect that Economists could empirically test the role of market power on tariff barriers and non-tariff barriers for all WTO member states in the future.

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Appendix A - Tables

Table A.1 : Tariff Binding Commitments and Market Power									
Dependent Variable	Tariff Binding								
Sectors	All Sectors					Manufacturing		Ariculture	
WTO members (#)	All (66)		All (42)	Originial (53)	New (14)	All (66)	All (42)	All (66)	All (42)
Estimation Method	Tobit	IV Tobit	Tobit	IV Tobit	IV Tobit	IV Tobit	Tobit	IV Tobit	Tobit
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Import Share	-0.76*** (0.23)	-0.95*** (0.28)		-0.93*** (0.36)	-0.37** (0.20)	-0.91*** (0.29)		-0.94*** (0.44)	
log (ω)			-0.47*** (0.15)				-0.009 (0.04)		-0.42 (0.49)
ε			0.01 (0.01)				-0.01*** (0.004)		0.003 (0.04)
log(GDP/Capita)	-2.00 (3.39)	-1.85 (3.37)		-6.95 (4.73)	-0.38 (3.43)	0.72 (3.23)		-10.09** (4.67)	
Political Instability	5.01** (2.04)	4.80** (2.00)		3.00 (2.62)	2.83 (1.51)	5.19*** (1.90)		3.83 (3.36)	
Country Dummy	No	No	Yes	No	No	No	Yes	No	Yes
Two Way Clustering	Yes	Yes	No	Yes	Yes	Yes	No	Yes	No
R-squared	0.0171	0.0170	0.04	0.0289	0.0160	0.0237	0.2032	0.0159	0.0390
# of observations	247742	228481	6050	170649	57832	210107	4443	37635	1607
Source: Table 4- Beshkar,Bond, and Rho (2012). Notes: Robust standard error in the regression with country dummy.									

Table A.2 : Tariff Overhang and Market Power

Dependent Variable	Tariff Binding								
Sectors	All Sectors					Manufacturing		Ariculture	
WTO members (#)	All (66)		All (42)	Originial (53)	New (14)	All (66)	All (42)	All (66)	All (42)
Estimation Method	Tobit	IV Tobit	Tobit	IV Tobit	IV Tobit	IV Tobit	Tobit	IV Tobit	Tobit
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Import Share	-1.73*** (0.52)	-3.73*** (0.95)		-3.65*** (0.92)	-4.45** (1.59)	-1.61*** (0.52)		-1.94*** (0.49)	
log (ω)			-0.41*** (0.06)				-0.15*** (0.04)		-0.13 (0.16)
ε			0.01** (0.06)				-0.007* (0.004)		0.01 (0.01)
log(GDP/Capita)	-1.15 (3.65)	-0.73 (3.61)		-5.78 (4.88)	-2.78 (3.48)	1.28 (3.50)		-9.3.7* (4.82)	
Political Instability	4.50** (2.18)	3.98** (2.12)		2.07 (2.68)	2.16 (1.43)	4.89** (2.11)		3.20 (3.35)	
Country Dummy	No	No	Yes	No	No	No	Yes	No	Yes
Two Way Clustering	Yes	Yes	No	Yes	Yes	Yes	No	Yes	No
R-squared	0.0191	0.0216	0.1294	0.0347	0.0225	0.0239	0.2063	0.0182	0.1563
# of observations	247742	228481	6050	170649	57832	210107	4443	37635	1607

Source: Table 5- Beshkar,Bond, and Rho (2012). Notes: Robust standard error in the regression with country dummy.

Table A.3 : Likelihood of Tariff at the Binding

Dependent Variable	Zero-Overhang Dummy								
Sectors	All Sectors					Manufacturing		Ariculture	
WTO members (#)	All (66)		All (42)	Originial (53)	New (14)	All (66)	All (42)	All (66)	All (42)
Estimation Method	Tobit	IV Tobit	Tobit	IV Tobit	IV Tobit	IV Tobit	Tobit	IV Tobit	Tobit
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Import Share	0.014*** (0.01)	0.037*** (0.02)		0.019*** (0.02)	0.12*** (0.09)	0.039*** (0.03)		0.023*** (0.03)	
log (ω)			0.002*** (0.001)				0.001 (0.001)		-0.00 (0.49)
ε			-0.00 (0.00)				0.0003* (0.0001)		-0.00 (0.00)
log(GDP/Capita)	0.015 (0.10)	0.008 (0.10)		0.051*** (0.11)	-0.025 (0.18)	0.006 (0.10)		0.024 (0.11)	
Political Instability	-0.049** (0.06)	-0.045*** (0.06)		-0.00133	-0.02 (0.11)	-0.045** (0.00)		-0.044** (0.08)	
Country Dummy	No	No	Yes	No	No	No	Yes	No	Yes
Two Way Clustering	Yes	Yes	No	Yes	Yes	Yes	No	Yes	No
R-squared	0.1536	0.1891	0.6447	0.3507	0.0721	0.1975	0.6918	0.1444	0.7227
# of observations	247742	228481	6050	170649	57832	210107	4443	37635	1607

Source: Table 6 in Beshkar, Bond and Rho (2012),robust standard error in the regression with country dummy. In OLS regression, dependent variable is the ratio of strong binding in HS 3-digit sectors. Marginal effect is reported in the probit regression.